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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, Washington 98101

January 24, 1997

Reply To
Attn Of: ECL-111

MEMORANDUM

SUBJECT: Bremerton Naval Complex
Operable Unit A (OU-A) Record of Decision (ROD)

FROM: Patty McGrath
Project Manager
Environmental Cleanup Office
Site Cleanup Unit III

TO: Chuck Clarke
Regional Administrator

On April 29, 1996 you were briefed by Barry Rogowski (Ecology's Project Manager) and myself on the Proposed Plan for OU-A. The preferred alternative discussed during the briefing and in the proposed plan included the following components:

- asphalt cap over unpaved areas of the site
- placement of riprap along the shoreline to reduce erosion
- institutional controls to ensure industrial land use and appropriate handling of soils excavated during normal shipyard maintenance activities
- continue shoreline access restrictions to prevent fish and shellfish harvesting
- groundwater monitoring

The cost of the preferred alternative was $1.4 million. Public comments indicated acceptance of the preferred alternative.

Attached is the final ROD for OU-A. Since there are no significant changes between the Proposed Plan preferred alternative and the selected remedy in the ROD, a briefing for the ROD has not been scheduled.

Consistent with guidance for a state-lead federal facility, representatives from the Environmental Cleanup Office (myself and Judi Schwarz) and the Office of Regional Council (Tod Gold) have reviewed the OU-A ROD. The Navy and Ecology have signed the ROD. I recommend that EPA sign it as well (see attached four signature sheets).

Please let me know if you require a briefing for the OU-A ROD or the Bremerton Naval Complex in general.

DECLARATION OF THE RECORD OF DECISION

RECEIVED

NOV 27 1996

Environmental Cleanup Office

SITE NAME AND LOCATION

Operable Unit A
Puget Sound Naval Shipyard
Bremerton, Kitsap County, Washington

STATEMENT OF PURPOSE

This decision document presents the selected remedial action for Operable Unit A at Puget Sound Naval Shipyard (PSNS), which was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan. This decision is based on the administrative record for these sites.

The lead agency for this decision is the U.S. Navy (Navy). The U.S. Environmental Protection Agency (EPA) approves of this decision and, along with the Washington State Department of Ecology (Ecology), has participated in the site investigation process, the evaluation of alternatives for remedial actions, and the selection of the remedy. Ecology concurs with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from Operable Unit A (OU A), if not addressed by implementing the response action selected in this Record of Decision (ROD), may present imminent and substantial danger to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDIES

The selected remedial actions at Operable Unit A at PSNS address the potential chemical exposures and associated risks to human health and the environment by providing for capping, erosion protection, institutional controls, monitoring of groundwater, and habitat enhancements. This action will reduce the exposure of humans and biota to contamination. The major components of the remedial action for OU A are listed below.

- Upgrade the pavement cap by application of new asphalt and a surface sealant over Zone II of the site (approximately 3.7 acres).
- Install approximately 1,400 linear feet of erosion protection along the perimeter of Zone II.
- Implement institutional controls that include access restrictions, restrictions on residential use, restrictions on fish and shellfish harvesting, and a Bremerton Naval Complex-wide soil management plan.
- Address the requirements for continued operation, inspection, and maintenance of the pavement cap and erosion protection. The Navy, Ecology, and the EPA will address these requirements, which will be consistent with a soil management plan and a facility-wide petroleum cleanup program for the Bremerton Naval Complex.
- Make enhancements to terrestrial and marine habitats.

- Conduct a groundwater monitoring program to sample and analyze groundwater for an initial monitoring period of 5 years to determine the trends of specified chemicals in groundwater. This monitoring program may require the construction of additional monitoring wells. A review of remedial measures will be undertaken at least every 5 years from the conclusion of the initial monitoring period.

- Develop a monitoring program for the above elements of the remedial action to assess their ongoing effectiveness.

If future land use changes or the Navy relinquishes ownership of the site, Ecology and EPA must be notified. Provisions will be made for covenants and deed restrictions for continued operation, maintenance, and monitoring of the selected remedy, for land use restrictions, use of groundwater, and to manage excavation. Potential remedies to address marine resources offshore of OU A will be detailed in the ROD for Operable Unit B. If there are additional measures required, those measures and any additional required monitoring will be defined in the ROD for Operable Unit B.

STATUTORY DETERMINATIONS

The selected remedial actions protect human health and the environment, comply with federal and state requirements that are legally applicable or relevant and appropriate to the remedial actions, and are cost-effective. Because treatment of the principal contamination source was found to be impractical, the remedies do not satisfy the statutory preference for treatment as a principal element.

Because these remedies will result in hazardous substances remaining above health-based levels at the site, a review will be conducted within 5 years after the remedial action commences (and at 5-year intervals thereafter) to ensure that the remedies continue to provide adequate protection of human health and the environment.

Signature sheet for the PSNS Operable Unit A Record of Decision between the U.S. Navy, the Washington State Department of Ecology, and the U.S. Environmental Protection Agency.

D. E. BAUGH Captain, U. S. Navy Commander, Puget Sound Naval Shipyard	1-29-97 Date

Signature sheet for the PSNS Operable Unit A Record of Decision between the U.S. Navy, the Washington State Department of Ecology, and the U.S. Environmental Protection Agency.

Mary E. Burg

Mary E. Burg, Program Manager
Toxics Cleanup Program
Washington State Department of Ecology

16 December 1996

Date

Signature sheet for the PSNS Operable Unit A Record of Decision between the U.S. Navy, the Washington State Department of Ecology, and the U.S. Environmental Protection Agency.

Charles C. Clarke ____________________ 1/24/97 ____________
Charles C. Clarke
Regional Administrator, Region 10
U.S. Environmental Protection Agency

Date

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ABBREVIATIONS AND ACRONYMS

ARAR	applicable or relevant and appropriate requirement
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	ambient water quality criteria
BEHP	bis(2-ethylhexyl)phthalate
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
cm/sec	centimeters per second
COPC	chemical of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSL	cleanup screening level
CWA	Clean Water Act
DDD	dichlorodiphenyldichloroethane
DDT	dichlorodiphenyltrichloroethane
DoD	U.S. Department of Defense
Ecology	Washington State Department of Ecology
EFA NW	Engineering Field Activity, Northwest
EPA	U.S. Environmental Protection Agency
ER-L	effects range-low
FS	feasibility study
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
HRA	Historical Radiological Assessment
IAG	Interagency Agreement
IAS	initial assessment study
IR	Installation Restoration
IRIS	Integrated Risk Information System
kg/yr	kilogram/year
μg/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
msl	mean sea level
MTCA	Model Toxics Control Act

ABBREVIATIONS AND ACRONYMS (Continued)

MWEP	monofilled waste extraction procedure
NAVFACENGCOM	Naval Facilities Engineering Command
Navy	U.S. Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PSAPCA	Puget Sound Air Pollution Control Agency
PSNS	Puget Sound Naval Shipyard
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RD/RA	remedial design/remedial action
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SF	slope factor
SI	site investigation
SMS	Sediment Management Standards
SQL	sample quantitation limit
SQS	sediment quality standards
SQV	sediment quality value
SVOC	semivolatile organic compound
TCLP	toxicity characteristics leaching procedure
TDS	total dissolved solids
TPH	total petroleum hydrocarbons
TRC	Technical Review Committee
URS	URS Consultants, Inc.

ABBREVIATIONS AND ACRONYMS (Continued)

USC	U.S. Code
VOC	volatile organic compound
WAC	Washington Administrative Code

DECISION SUMMARY

1.0 INTRODUCTION

In accordance with Executive Order 12580, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the U.S. Navy (Navy) is addressing environmental contamination at Puget Sound Naval Shipyard (PSNS) Operable Unit (OU) A by undertaking remedial action. The selected remedial action has the concurrence of the Washington State Department of Ecology (Ecology) and the approval of the U.S. Environmental Protection Agency (EPA) and is responsive to the expressed concerns of the public. This Record of Decision (ROD) is intended to fulfill the state and federal requirements for a cleanup action plan. The selected remedial actions will comply with applicable or relevant and appropriate requirements (ARARs) promulgated by Ecology, EPA, and other state and federal agencies.

2.0 SITE NAME, LOCATION, DESCRIPTION, AND HISTORY

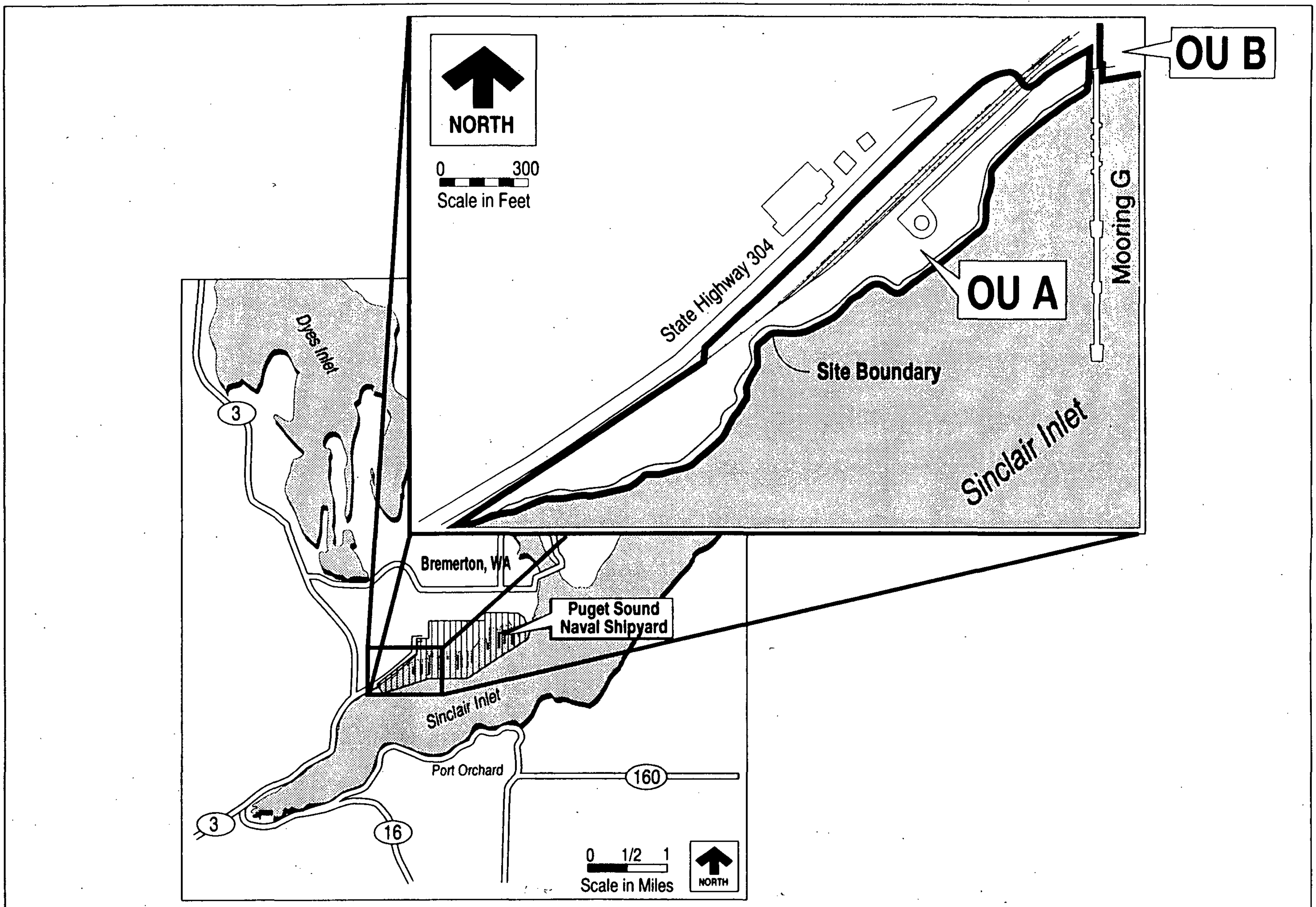
OU A is located within the Bremerton Naval Complex (which includes PSNS, the Fleet and Industrial Supply Center, and associated tenants), along the shoreline of Sinclair Inlet in Bremerton, Washington (Figure 2-1). OU A is mostly surrounded by fencing and is regularly patrolled by base security. The Navy designated the Bremerton Naval Complex in 1891. The first drydock was completed in 1896, and military and industrial support activities have continued from that time to the present. Prior to the establishment of regulations governing waste disposal, some wastes used at the shipyard were disposed of or used as fill material, a practice considered acceptable at the time. The site now comprises parking areas for visitors, naval personnel, and shipyard workers.

OU A is one of four operable units of the Bremerton Naval Complex (A, B, C, and NSC). OU A encompasses approximately 12 acres of filled land that was created over time starting in the 1940s. OU A formerly included 27 acres of intertidal and subtidal areas adjacent to the filled areas. These marine areas were included with other portions of the shipyard in OU B to address chemical levels in the marine environment as a whole. The entire site is bounded on the north and west by State Highway 304, on the east by Mooring G, and on the south by Sinclair Inlet. The terrestrial portion of the site is bounded by a steep (angle of repose) 10- to 15-foot riprap embankment, with an average top elevation of 10 feet above mean sea level (msl). Although marine portions of the site were investigated during the remedial investigation (RI) and feasibility study (FS), remedial alternatives for marine resources will be addressed as part of the remedial actions at OU B. If the RI activities at OU B indicate a need for further action at OU A to protect marine resources, those actions (if any) will be defined in the OU B ROD.

During the RI/FS, the site was divided into three zones (Figure 2-2):

- Zone I, the Charleston Beach parking lot
- Zone II, U.S.S. *Missouri* parking lot (and former helicopter pad)
- Zone III, the upland parking lot between the railroad tracks and State Highway 304

These zones differ on the basis of site history, ownership, and degree and type of site contamination. Zones I and II were created from filling operations between 1946 and



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 2-1** **Operable Unit A Vicinity Map**	CTO 0160 PSNS OU A Bremerton, Washington FINAL ROD

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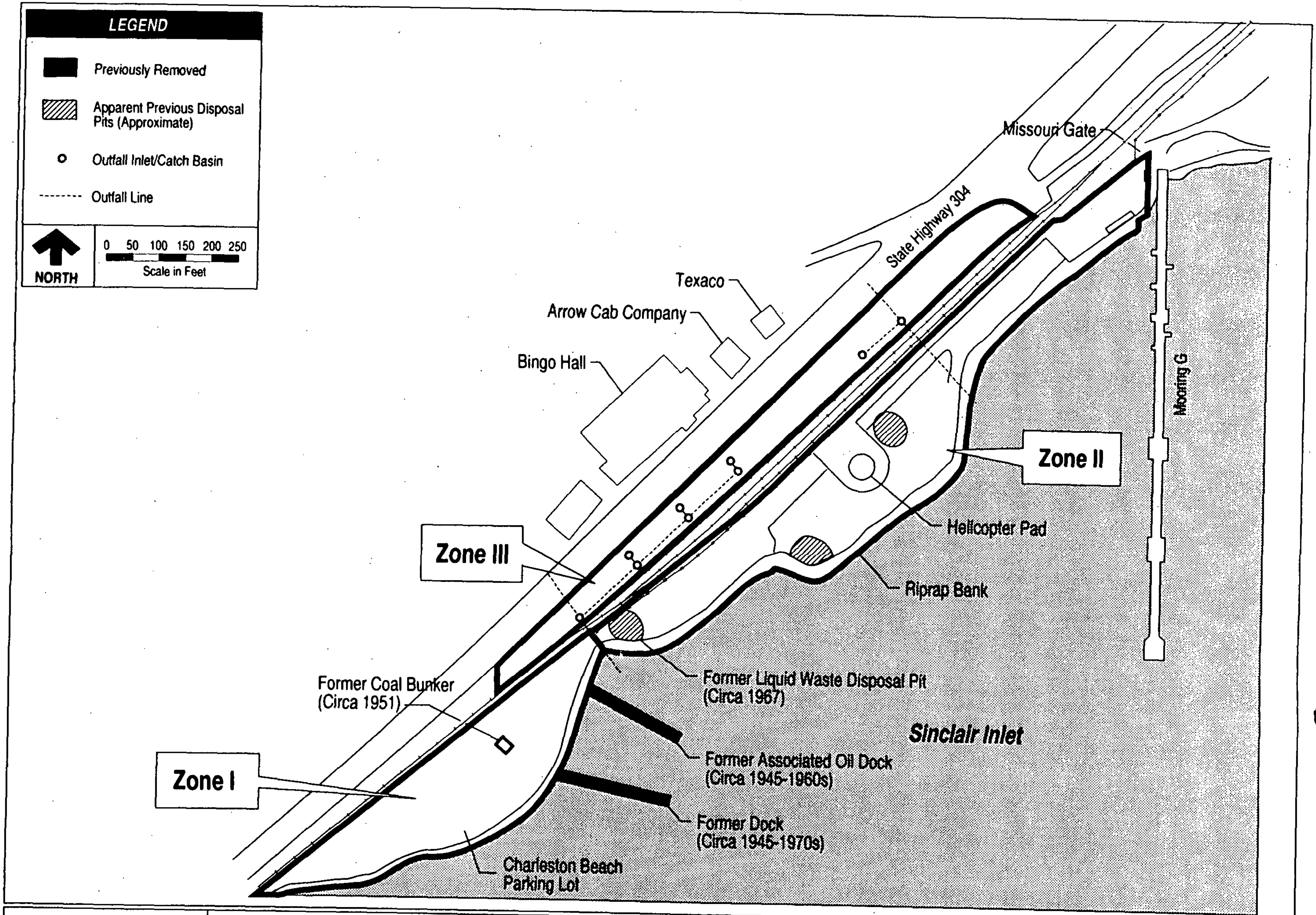

CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 2-2** **Approximate Locations of Investigatory Zones and Previous Industrial Activities**	CTO 0160 PSNS OU A Bremerton, Washington FINAL ROD

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the early 1970s. Fill included dredge spoils, spent sandblast grit, construction debris, and industrial wastes. During the RI/FS, the major portion of contamination was documented in Zone II. Consequently, the remedy will focus primarily on this portion of the site, although the ROD addresses the entirety of OU A.

Zone I

The Charleston Beach parking lot was expanded to its current size between 1946 and 1956. Presumably the fill used for this purpose was the same material used for the helicopter pad. No hazardous waste disposal activities in Zone I have been identified; however, industrial activities, including a former coal bunker and fuel loading docks, occupied portions of the site in the past (Figure 2-2).

Zone II

Most of the disposal of what is now known as hazardous waste at OU A occurred within the confines of Zone II. Fill was added to Zone II between 1946 and the early 1970s. A helicopter pad was constructed in the center portion of this zone in the early 1960s. The entire Missouri Gate parking lot in Zone II was paved in 1995. Before this, the gravel parking surface was occasionally covered with oil to reduce dust generation. Between 1963 and 1972, approximately 30,000 gallons of liquid wastes were disposed of in unlined pits that ultimately emptied into Sinclair Inlet. Starting in the mid-1950s, 6,000 to 8,000 tons per year of copper slag grit were used for sandblasting at PSNS. Some of this material, as well as dredge spoils from Drydock 6, was evidently placed in Zone II as fill. Old Navy drawings also indicate that burn pits existed in Zone II in the past (U.S. Navy 1986). These past disposal areas are shown in Figure 2-2.

Zone III

Zone III is the upland parking lot, which is situated between the existing railroad tracks and State Highway 304. This area represents the 1946-era shoreline. Before this area was converted to a parking lot in the mid-1980s, six railroad tracks (rather than the current three) were located at the site. No documented record of disposal activities exists for this portion of OU A.

3.0 SITE ENFORCEMENT ACTIVITIES

In response to the requirements of CERCLA, the U.S. Department of Defense (DoD) established the Installation Restoration (IR) program. The Navy, in turn, established a Navy IR program to meet the requirements of CERCLA and the DoD IR program. Responsibility for the implementation and administration of the IR program is assigned to the Naval Facilities Engineering Command (NAVFACENGCOM). The Southwest Division of NAVFACENGCOM has responsibility for the western states. Engineering Field Activity, Northwest (EFA NW) has responsibility for investigations at PSNS and other naval installations in the Pacific Northwest and Alaska.

In 1983, the Navy conducted an initial assessment study (IAS) to investigate the possibility of contamination at sites at PSNS (NEESA 1983). From 1990 to 1991, the Navy performed a site investigation (SI) of the Bremerton Naval Complex. The SI report concluded that no immediate removal actions were necessary for the protection of human health and the environment, but that further investigation was warranted (URS 1992b). In 1992, the Navy prepared project management plans for an RI/FS at OU A (URS 1992a).

Representatives of the Agency for Toxic Substances and Disease Registry (ATSDR) investigated all of the National Priorities List (NPL) sites of the PSNS complex to develop a human health assessment. ATSDR's draft report indicated no immediate concerns related to OU A, a conclusion that is consistent with the SI.

As the RI/FS work progressed, Ecology, EPA, and the Navy began working together to investigate possible contamination from past practices at OU A. In June of 1994, PSNS was listed on the NPL, a federal list of contaminated sites. Preceding the listing on the NPL, Ecology had issued Enforcement Order No. DE 92 TC-112 on May 15, 1992, requiring PSNS to complete a remedial investigation/feasibility study and draft cleanup plan for the site. RI/FS activities were initiated by EFA at the site in 1992 with the publication of the draft RI work plans. RI/FS activities have been ongoing at OU A since that time.

In the absence of a Federal Facilities Agreement at this site, the Navy, EPA, and Ecology will negotiate an Interagency Agreement (IAG) within 180 days of the signing of this ROD. The IAG will provide the legal framework in accordance with Section 120(e) of CERCLA for the expeditious completion of the remedial activities. OU A is not currently the subject of Resource Conservation and Recovery Act (RCRA) regulatory authorities.

In August and October 1995, the final RI and FS reports for OU A were completed (URS 1995a, 1995b). The purpose of the RI/FS was to characterize the site, determine the nature and extent of contamination, assess human and ecological risks, and evaluate remedial alternatives. A proposed plan addressing the Navy's preference for remedial actions was published for public comment in May 1996 (URS 1996b). Additional documents prepared to support the proposed plan were the treatability study report (Foster Wheeler 1996) and the groundwater modeling report (URS 1996a).

4.0 COMMUNITY RELATIONS

Federal and state requirements for public participation include providing the proposed plan to the public. The Navy also involved the community by having open houses, public meetings, a Technical Review Committee (TRC), and a Restoration Advisory Board (RAB). Fact sheets were distributed to the surrounding residents to keep them updated on the status of environmental cleanup projects at PSNS. The proposed plan, which included the action selected for OU A in this ROD, and the RI/FS were provided to the public on May 7, 1996. An open house and public meeting were held at the Washington Mutual Building in Bremerton on May 28, 1996, during which representatives from the Navy, Ecology, and the EPA answered questions about the site and the remedial alternatives under consideration. The public comment period was from May 7 to June 15, 1996. Twenty-five comments on the plan were received. The responsiveness summary, which includes responses to comments, is included in this ROD as Appendix A.

The decision for remedial action described in this ROD is based on the administrative record for the site. The primary documents pertaining to this investigation can be reviewed at the following locations:

Central Library
1301 Sylvan Way
Bremerton, Washington
(360) 377-7601

Downtown Branch Library
612 Fifth Avenue
Bremerton, Washington
(360) 377-3955

Port Orchard Branch Library
87 Sidney Avenue
Port Orchard, Washington
(360) 876-2224

The official collection of all site-related documents is contained in the administrative record for PSNS. Related documents have been available since the results of the IAS were published (NEESA 1983). The public is welcome to review the administrative record by appointment at the following location:

Engineering Field Activity, Northwest
Naval Facilities Engineering Command
19917 Seventh Avenue N.E.
Poulsbo, Washington 98370
(360) 396-0298

A dialogue has been established among the stakeholders, which include citizens living near the site, other interested organizations, the Navy, Ecology, and the EPA. The actions taken to satisfy the statutory requirements also provided a forum for citizen involvement and input to the proposed plan and the ROD, including the following:

- Creation of a community relations plan/public participation plan in October 1992 (URS 1992c) and revision by PSNS in April of 1994.
- Mailing fact sheets periodically and mailing newsletters on a trimester basis to approximately 1,400 interested individuals on an established mailing list. The list includes nearby residents, community members, news media, regulatory agencies, elected representatives, tribal members, and special interest groups.
- TRC meetings with representatives from the public and governmental entities, including the EPA, Ecology, the Department of Fish and Wildlife, the Sierra Club, and the Suquamish Tribe. The TRC was established in 1991 and was replaced by the RAB in 1994.
- Public meetings and open houses held in 1994, 1995, and 1996 to inform citizens about the ongoing environmental investigations at PSNS.
- Newspaper advertisements for the open houses and public meetings.
- A public meeting and open house on May 28, 1996, to present the preferred remedial actions and the findings of the investigations and to receive comments on the proposed plan. Twenty-six people attended the

open house and 20 people attended the public meeting. A public comment period was held on the proposed plan for OU A from May 7 to June 15, 1996.

In the National Defense Authorization Act for Fiscal Year 1995 (Senate Bill 2182), Section 326(a), Assistance for Public Participation in Defense Environmental Restoration Activities, the DoD was directed to establish RABs in lieu of TRCs. In 1994, PSNS established a RAB for the following purposes:

- To act as a forum for monthly discussions and exchange of information between the Navy, regulatory agencies, and the community regarding environmental restoration topics. The RAB is part of a process that addresses community concerns and issues during the cleanup process.

- To provide an opportunity for stakeholders to review progress and participate in the decisionmaking process by reviewing and commenting on actions and proposed actions involving releases or threatened releases at the installation. However, the RAB itself does not serve as a decisionmaking body.

- To serve as an outgrowth of the TRC concept by providing a more comprehensive forum for discussing environmental cleanup issues and by serving as a mechanism for RAB members to give advice as individuals.

- To meet monthly under citizen co-chairpersons, elected by citizen RAB members.

The RAB members consist of civic, private, tribal, local government, and environmental activities groups, as well as representatives from the Navy and regulatory agencies.

5.0 SCOPE AND ROLE OF RESPONSE ACTIONS WITHIN SITE STRATEGY

OU A is one of four operable units at the Bremerton Naval Complex. The operable units (A, B, C, and NSC) were organized on the basis of Navy command structure, geographic location, site history, and suspected contamination. Separate RIs are being conducted for OUs A, B, and NSC at the Bremerton Complex. The draft RI report for OU B is scheduled to be released and the ROD for OU NSC is expected to be completed in the fall of 1996. Because the significant contamination at OU C is limited to petroleum in soil and groundwater, a formal RI is not being performed at this site. Instead, this operable unit has been the subject of a limited field investigation and pilot treatability test involving steam injection.

This ROD addresses OU A at PSNS. OU A originally included marine sediments, but these media were subsequently included in OU B so that the marine environment at PSNS would be addressed as a whole. Results of marine sediment and biota sampling near OU A will be described in the OU B ROD in order to determine if terrestrial portions of OU A represent sources of contamination to the marine environment. Work at OU B will address marine sediments in Sinclair Inlet.

Puget Sound Naval Shipyard has prepared a Historical Radiological Assessment (HRA) for the Bremerton Naval Complex to determine whether past work with radioactive materials at the complex could present a risk to human health or the environment. Policies for preventing environmental contamination, historical records of potential releases to the environment, and results of ongoing environmental sampling were reviewed in preparation of the HRA. No evidence of any radionuclides above background levels was found by the Navy at OU A during this evaluation; however, the EPA is still reviewing a portion of the HRA. As a matter of comity, at the request of Washington State and EPA Region 10, the shipyard will perform limited soil and groundwater sampling to confirm the conclusions of the HRA.

The cleanup action for OU A is being undertaken to accomplish several objectives:

- Limit exposure to contaminated soils and shellfish
- Reduce the erosion of contaminated fill at the perimeter of the site into Sinclair Inlet

- Reduce chemical flux rates in groundwater to protect marine resources
- Enhance terrestrial and marine habitat, since these goals can be accomplished concurrently with the upgrading of the existing riprap

6.0 SUMMARY OF SITE CHARACTERISTICS

This section summarizes regional characteristics and site conditions, including discussions of the ecological setting, climate, surface water patterns, geology, and hydrogeology, as well as the nature and extent of chemicals of concern at OU A.

6.1 ECOLOGICAL SETTING

6.1.1 Regional Flora

There are two main types of vegetation in and around the area: terrestrial and marine. The naval complex is situated within the terrestrial zone of western hemlock (*Tsuga heterophylla*). If major land alteration had not occurred, the naval complex would have been typical of this zone, which contains some of the densest forest in the continental United States.

The marine flora consist largely of sea lettuce (*Ulva lactuca*), popweed (*Fucus distichus*), and various algae. The predominant species is eelgrass (*Zostera marina*), which lends itself well to the shallow, sandy intertidal sediments and moderate currents. Eelgrass reduces turbidity, stabilizes sediments, and alters wave action.

6.1.2 Site Flora

Although the naval complex has areas of vegetation interspersed among the industrial areas, no endemic vegetation is present in the OU A study area. Except for a few unpaved bermed areas reserved for landscaping, the parking areas are paved. A small area (ca. 0.5 acre) just southwest of the Charleston Beach parking lot (Charleston Beach proper) is unpaved (Figure 2-2).

6.1.3 Regional Fauna

The terrestrial wildlife in the area includes deer, black bear, lynx, fox, coyote, a large variety of birds, small rodents, reptiles, and amphibians. The year-round bird population includes Stellar's jay, starling, flicker, crow, black-capped chickadee, robin, goldencrowned kinglet, evening grosbeak, and ring-necked pheasant. Glaucous-winged gulls and other migratory waterfowl frequent the area during migration seasons.

Marine fauna in the area consist of a variety of oysters, clams, crabs, mussels, scallops, octopi, sea cucumbers, and numerous fish species. Invertebrates common to the riprap shoreline include barnacles, bay mussels, and polychaete worms. River otters, harbor seals, and harbor porpoises are also present.

6.1.4 Site Fauna

Most of the mammals inhabiting the naval complex and the study area (e.g., shrews, mice, rabbits, squirrels, and moles) are small and none were observed in the fall of 1994. Common rats were observed during a site visit in 1995. Reptile and amphibian life is predominantly confined to garter snakes, turtles, salamanders, newts, and frogs. Glaucous-winged gulls are the predominant bird at the site.

6.1.5 Threatened or Endangered Species

There are no listed or proposed endangered species at the Bremerton Naval Complex. The only threatened species known to exist in Kitsap County (but not on site) is the bald eagle.

6.1.6 Environmentally Sensitive Areas

The naval complex includes no wetlands. The intertidal marine environment along the shipyard may be considered an environmentally sensitive area.

6.2 CLIMATE

Because of its proximity to the Pacific Ocean and the influences of Puget Sound, the Kitsap Peninsula experiences a cool maritime climate. The Cascade and Olympic Mountain ranges also influence the area's weather. Average temperatures range from approximately 70°F in the summer to 40°F in the winter.

The prevailing winds of fall and winter are southwesterly. Spring and summer prevailing winds are from the northwest. Wind velocity from June to September ranges from 0 to 9 miles per hour; from October to May it often reaches 20 miles per hour. Bremerton's average annual rainfall is 45 inches. The maximum monthly precipitation occurs in December (9.4 inches) and the minimum occurs in August (0.6 inch). Approximately 85 percent of the precipitation occurs between October and April. Summer rainfall is limited to isolated shower activity. Winter snowfall is generally light and seldom exceeds a depth of 3 to 6 inches.

In the winter, 5 to 8 days per month are clear or partly cloudy; in the summer, about 20 days per month are clear or partly cloudy. Relative humidity ranges from 50 to 100 percent during the day and from 75 to 100 percent at night. Fog occurs an average of 10 percent of the time, rising to as high as 20 percent in October and November.

6.3 SURFACE WATER HYDROLOGY

6.3.1 Regional Surface Water Characteristics

There are 3 miles of marine shoreline along the naval complex. Sinclair Inlet is part of Puget Sound, which in 1988 was formally designated as an estuary of national significance under the Clean Water Act (CWA). Sinclair Inlet is rated as a Class A (excellent) body of water by Ecology. Under this classification, water uses to be protected include anadromous fish migration and rearing, commercial fish and shellfish reproduction and harvesting, boating, fishing, aesthetics and water-contact recreation, industrial water supply, and navigation. Sinclair Inlet is currently closed to commercial shellfish harvesting due to fecal coliform contamination from other sources, but is open to private harvesting. Anecdotal information suggests that shellfish harvesting may have been conducted periodically in the past from Charleston Beach.

6.3.2 Site Surface Water Characteristics

Because the site is nearly flat, mostly paved, and contains no streams or wetlands, surface water appears to drain exclusively into inlets and catch basins and then via two stormwater pipes directly to Sinclair Inlet (Figure 2-2). Little to no flooding potential exists at the site.

6.4 GEOLOGY

6.4.1 Regional Geology

The Puget Lowland physiographic province, which lies between the Cascade and Olympic Mountains, is, for the most part, a structural depression covered by glacial deposits. Although Puget Sound is generally deep throughout its length, with depths of 600 to 800 feet being common, shallow sills divide it into distinct cells with partially restricted bottom circulation.

Two types of preglacial rock are present in the area. These preglacial formations are largely obscured by the glacial deposits, with only occasional occurrences of Tertiary Period rock groups outcropping in the region. The pre-Tertiary history of the region is not well known, owing to the thick blanket of Tertiary and Quaternary deposits. Along the northwest bank of Sinclair Inlet is an extrusive igneous outcropping, believed to have accumulated during early Eocene time. These Tertiary volcanics consist predominantly of basalt flows and interbedded tuffs and agglomerates assigned to the Crescent Formation. Overlying these Eocene basalts is the Blakely Formation, a thick sequence of Oligocene Epoch shallow marine sedimentary rocks. These sedimentary strata include conglomerate, sandstone, and shale derived largely from the highlands to the east. Subsequent deformation of the formations in the late Tertiary Period produced the present-day Cascade and Olympic Mountain chains and the Puget Trough.

During the Pleistocene Epoch, the Puget Lowland experienced a series of continental glaciations, the most recent of which occurred between 15,000 and 13,500 years ago. Admiralty Drift is the oldest known formation of the Pleistocene Epoch. The drift, consisting principally of blue clay and silt, contains some sand, gravel, lignite, and volcanic ash. Overlying the drift is the Orting gravel, composed mainly of stream-deposited sand and gravel. The lower member of the Orting gravel is a lightly cemented deposit of sand and gravel, while the upper member is primarily clay, but contains strata of peat, sand, gravel, and glacial till. The Puyallup sand overlies the clay member of the Orting gravel. This sedimentary formation ranges from finely laminated sands and silt to massive sand strata.

During the latest glaciation, known as the Vashon Stade of the Fraser Glaciation, a continental ice sheet blocked normal drainage from Puget Sound to the Pacific Ocean. A large lake formed in front of the advancing ice sheet, resulting in the deposition of lacustrine silts and clays followed by glacial deposits as the ice moved southward. The retreat of the ice sheet reopened drainage to the northwest and left behind a thick accumulation of glacial and nonglacial deposits and landforms that characterize the Puget Lowland today. This material is called the Vashon Drift Till and Outwash. The glacial till is an unsorted mixture of clay, silt, sand, gravel, and boulders deposited as a basal till beneath the ice. The recessional outwash consists of sand, silts, and gravel deposited by the meltwater from the glacier.

There are four basic types of soils in Kitsap County:

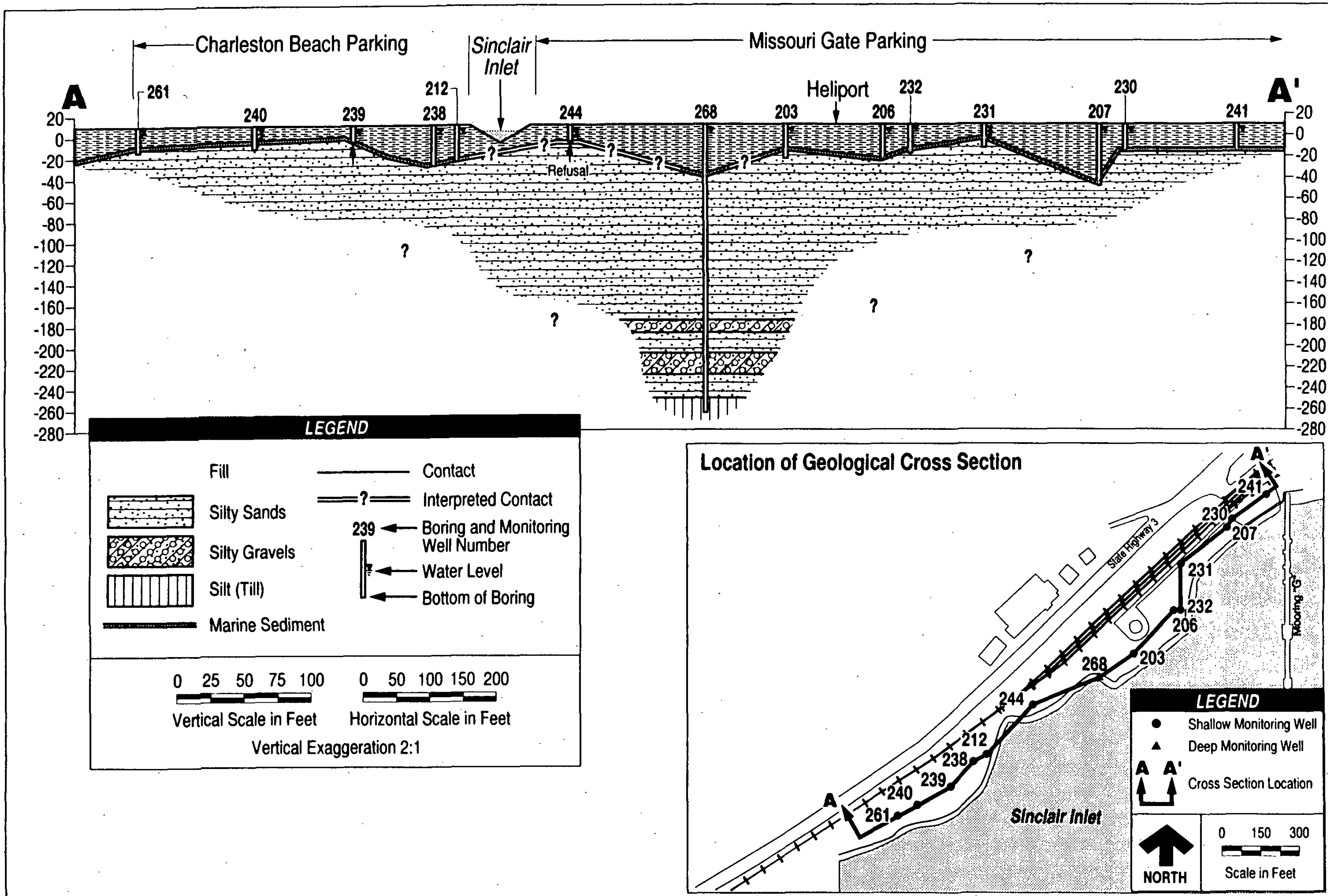
- Soils underlain by hardpan or bedrock substrate. These include the soils of the Alderwood, Sinclair, Edmonds, and Melbourne series.
- Soils with highly permeable, distinctly stratified substrata such as the Everett, Indianola, and Kitsap series, and undifferentiated alluvial soil. These soils are coarse and have high to excessive permeability.
- The organic soils represented by small, widely scattered areas of Greenwood, Rifle, and Spalding peats and muck.
- Soils with little or no agricultural or building potential. Typical landforms include rough mountainous land, steep broken land, coastal beaches, and tidal marshes.

The shipyard has been altered significantly from its natural condition. Portions of the upland areas of the naval complex were cut to fill marshes and create level land. The resulting fill material was predominantly a silty, gravelly sand with occasional pockets of silts and clays. The surface of the filled areas is generally a uniform layer of soil.

The remaining areas of natural soil vary from dense glacial till to soft bay mud and peat. The upland soil has been classified as moderately to highly permeable Alderwood loam underlain by a low-permeability hardpan soil. The lowland soils are deep and cohesionless.

6.4.2 Site Geology

The geology of OU A is illustrated on Figure 6-1. A generalized geologic column through the subsurface, from youngest to oldest sediments, would include recently installed pavement (1995), undifferentiated fill, bay mud, brown/gray sands and gravel,



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 6-1** **Site Geologic Cross Section**	CTO 0160 PSNS OU A Bremerton, Washington FINAL ROD

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fine gray sands, gray clayey silt, and the Clover Park Formation Till. Fill increases in thickness toward Sinclair Inlet. Undifferentiated till (Kitsap Formation) is present within the brown/gray sands in the inland areas but absent near the shore.

The surficial deposits at the study area consist of heterogeneous fill materials used to infill former wetland areas along the waterfront. The fill consists of sediments (various combinations of sand, gravel, silt, clay, and shells) and manmade materials including asphalt, concrete, wood, brick, coal, multi-colored sands, sandblast grit, metal scraps and shavings, paint chips, glass, burnt material, black oil, plastic, and pipe fragments. The fill materials are covered almost entirely by asphalt pavement. The fill materials range in thickness from about 2 to about 35 feet in the site vicinity. The area southwest of the Charleston Beach parking lot (Charleston Beach proper) is unpaved.

Fill thickness at the site is greatest along the shoreline by the helicopter pad, which is farthest from the original shoreline. The fill thickness in the middle of the site varies greatly.

The fill thickness at the northwest boundary of the site and along the southeast edge of State Highway 304 varies only moderately. Fill material along State Highway 304 slopes to the southeast toward Sinclair Inlet. This material and the fill west of State Highway 304 consist of a silty, gravelly sand with no debris other than concrete and wood identified in the boreholes. The thickness of the fill material increases from northwest to southeast, toward the water. The lowest elevations to which fill extends that were encountered during the RI were at MW204 and MW205, at a depth of 35 feet below ground surface (bgs) (elevation -25 feet msl), and the shallowest area was at MW267, at a depth of 6 feet bgs (+4 feet msl). The approximate elevation of the ground surface across this site is 10 feet msl. Based on approximate site dimensions and measured fill depths, the total volume of fill at OU A is estimated to be 325,000 cubic yards.

Below the fill material at OU A, marine sediments (bay muds) are encountered at some locations. The bay muds separate the fill from the native soils at several locations, where they provide a partial barrier to the vertical migration of groundwater. They consist of gray, sandy, silty biogeneous and terrigeneous sediments that are very cohesive and contain abundant in-place shell fragments and organic matter. The bay muds have a distinct odor caused by the decay of organic matter such as plants and marine organisms.

PSNS is underlain by the Vashon Drift and Puyallup Sands. The sediments beneath the fill at PSNS consist of alluvial sands and beach deposits. Local lenses of gravelly clay appear to have filled natural erosion channels in the alluvium at several locations. In addition, a discontinuous undifferentiated till unit (Kitsap Formation) was identified within the alluvium at several locations across the site.

6.5 HYDROGEOLOGY

6.5.1 Regional Hydrogeology

Hansen and Molenaar (1976) described an upper and lower aquifer, both composed of sand and gravel layers, within Kitsap County. The upper aquifer overlies a silt and clay layer throughout the area. Its base elevation ranges from near sea level to 200 to 300 feet above sea level. The saturated thickness of this aquifer ranges from 20 feet to more than 200 feet. Wells tapping this unconfined aquifer have water levels at elevations ranging from near sea level along the coast to 240 feet or more in the interior uplands.

The lower aquifer occupies elevations ranging from slightly above to approximately 300 feet below sea level, and ranges in thickness from a few feet to more than 300 feet. The confining layers of silt and clay range in thickness from a few feet to more than 200 feet. When penetrated, the water in this aquifer will rise in the casing to above the top of the aquifer, and in areas along the coast, artesian flows exist. Groundwater in both aquifers moves in the direction of Sinclair Inlet.

Potable water is supplied to PSNS and most of the surrounding area by the City of Bremerton Water Department. The primary source of water for the distribution system is the Casad reservoir on the Union River, which supplies approximately 80 percent of the volume used. The remaining portion is supplied from Anderson Creek reservoir and several deep, large-volume wells. There are no wells drawing groundwater downgradient from the site.

6.5.2 Site Hydrogeology

In general, the groundwater flow in the Bremerton area is from northwest to southeast, with recharge occurring in the upper portions of the area and discharging to Sinclair Inlet. The overall groundwater flow direction at OU A is toward Sinclair Inlet; however, during high tides, the direction of groundwater flow along the shoreline reverses and the groundwater flows landward.

For the RI (URS 1995a), groundwater level measurements were collected in monitoring wells and the tidal reference station following low and high tides. Figure 6-2 shows the potentiometric surface at low tide during Phase II (dry season) using tidal survey data collected on September 10, 1994. Tidal influence has a substantial effect on the groundwater flow direction beneath OU A, since the tidal range was measured to be in excess of 12 feet during the RI. No significant seasonal variation in tidal fluctuations or groundwater levels was observed between wet and dry seasons.

The water level measurements indicate that during high tide, the flow is from Sinclair Inlet into the site, and during low tide, the flow is from the site into Sinclair Inlet. Measured water levels in MW268 (deep well) and MW205 (shallow well) suggest an upward vertical gradient for this portion of the site.

The groundwater seepage velocity, based on mean water levels, is approximately 1.4 feet per day. Based on the maximum gradient at high tide, the maximum seepage velocity is 9.3 feet per day. A groundwater flow reversal from the bay to inland at a velocity of 3.3 feet per day causes a 50- to 100-foot-wide dilution zone where salt water and fresh water mix. Chlorides and other solutes diffuse into the fresh water farther inland until equilibrium is achieved. Tides influence water levels as much as an estimated 300 feet inland.

6.6 SCREENING LEVELS

Using Ecology guidance, chemicals of interest were identified as those present in sampled media at concentrations higher than the screening levels, including Ecology Model Toxics Control Act (MTCA) cleanup levels. MTCA A and B levels are in large part based on protecting residential exposure at the 10^{-6} cancer level and a hazard index (HI) of 1. MTCA C industrial levels are generally based on industrial worker exposure.

Results of the analyses are compared to regulatory (risk-based) screening levels and background concentrations (metals only) appropriate for the media of interest. MTCA Method C (and for some chemicals, Method A) has been chosen as the applicable screening level for surface and subsurface soil because OU A and adjacent properties have been zoned and used as industrial areas and will remain so for the foreseeable future.

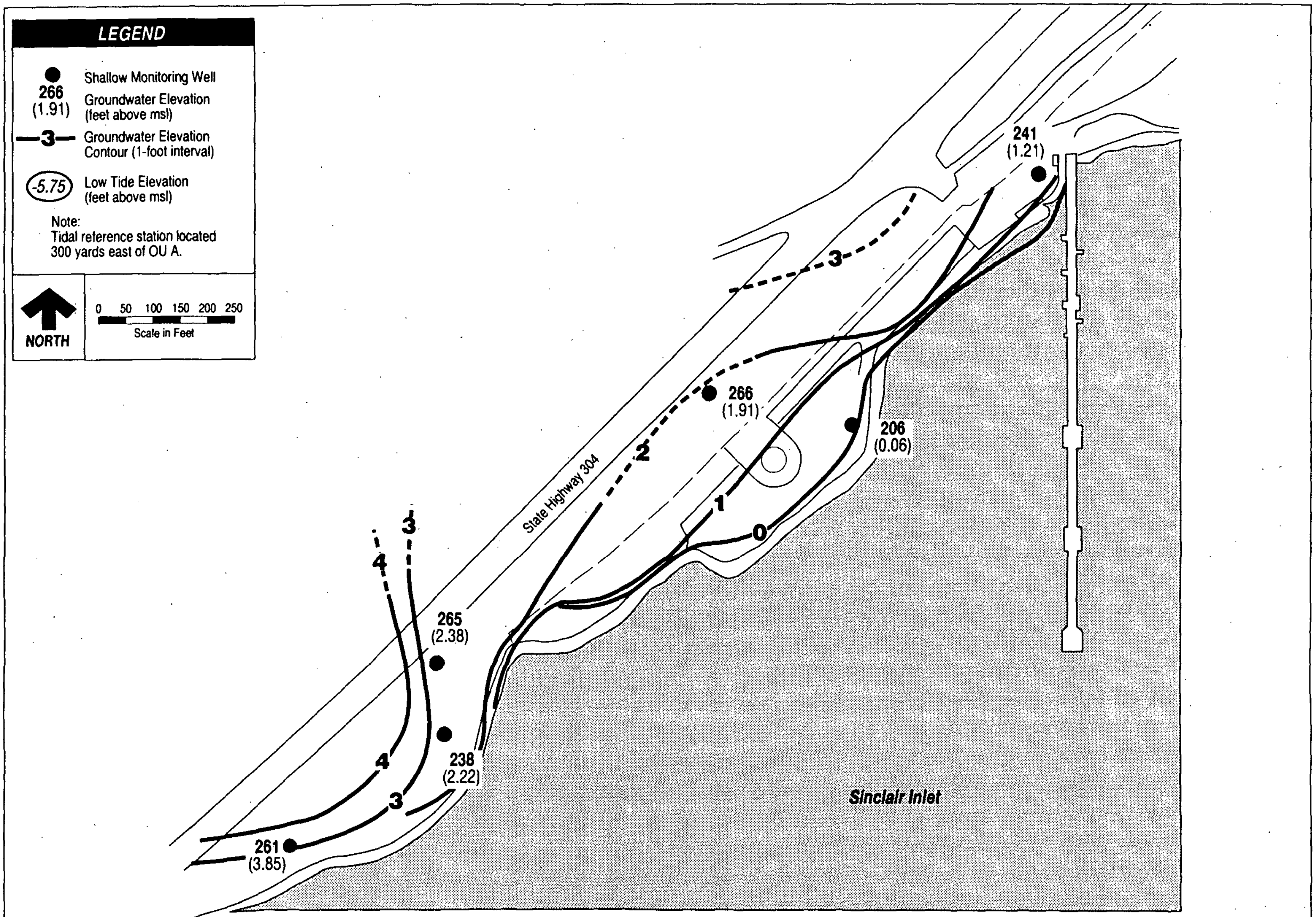

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Figure 6-2
Potentiometric Surface Map at Low Tide
(September 10, 1994)

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Groundwater levels were not screened against drinking water standards since groundwater is not potable at OU A. Because of the proximity of OU A to Sinclair Inlet, surface water screening criteria were used to evaluate groundwater at the site. The surface water screening criteria included state and federal marine ambient water quality criteria (AWQC) and MTCA B and the National Toxics Rule standard of 10^{-6} risk from the human consumption of organisms. The sediment quality standards (SQS) in the Washington State Sediment Management Standards (SMS) (WAC 173-204) were used to screen marine sediments.

6.7 NATURE AND EXTENT OF CONTAMINANTS

A detailed discussion of the nature and extent of chemicals detected at OU A is included in the RI report (URS 1995a) and summarized below.

Environmental media sampled during the RI included surface and subsurface soil, groundwater, surface water, marine sediment, and shellfish tissue. Locations of sampling points are shown on Figure 6-3. Bioassays were also conducted on marine sediment. Samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, cyanide, hexavalent chromium (for soils, groundwater, and surface water), and total petroleum hydrocarbon (TPH) compounds. The toxicity characteristics leaching procedure (TCLP) and monofilled waste extraction procedure (MWEP) were also performed on selected soil samples from OU A. Analytical data from three sampling events between 1990 and 1994 were obtained for evaluation of the nature and extent of chemicals in environmental media at the site. Numbers and types of samples by media are summarized in Table 6-1. Chemicals of concern and exceedances of regulatory standards (including MTCA Method A, A Industrial, B, and C Industrial cleanup levels; surface water criteria [WAC 173-201A] Clean Water Act standards; and National Toxics Rule standards) are listed for soil in Table 6-2, for groundwater in Table 6-3, and for surface water in Table 6-4. On-site locations at which contamination exceeded relevant screening levels are shown on Figure 6-4.

The terrestrial portion of OU A has been divided into three zones based on site history and location. The following discussion of chemicals of interest in soil, groundwater, surface water, and marine sediments at OU A focuses on the extent to which the chemicals of interest are present in the three zones.

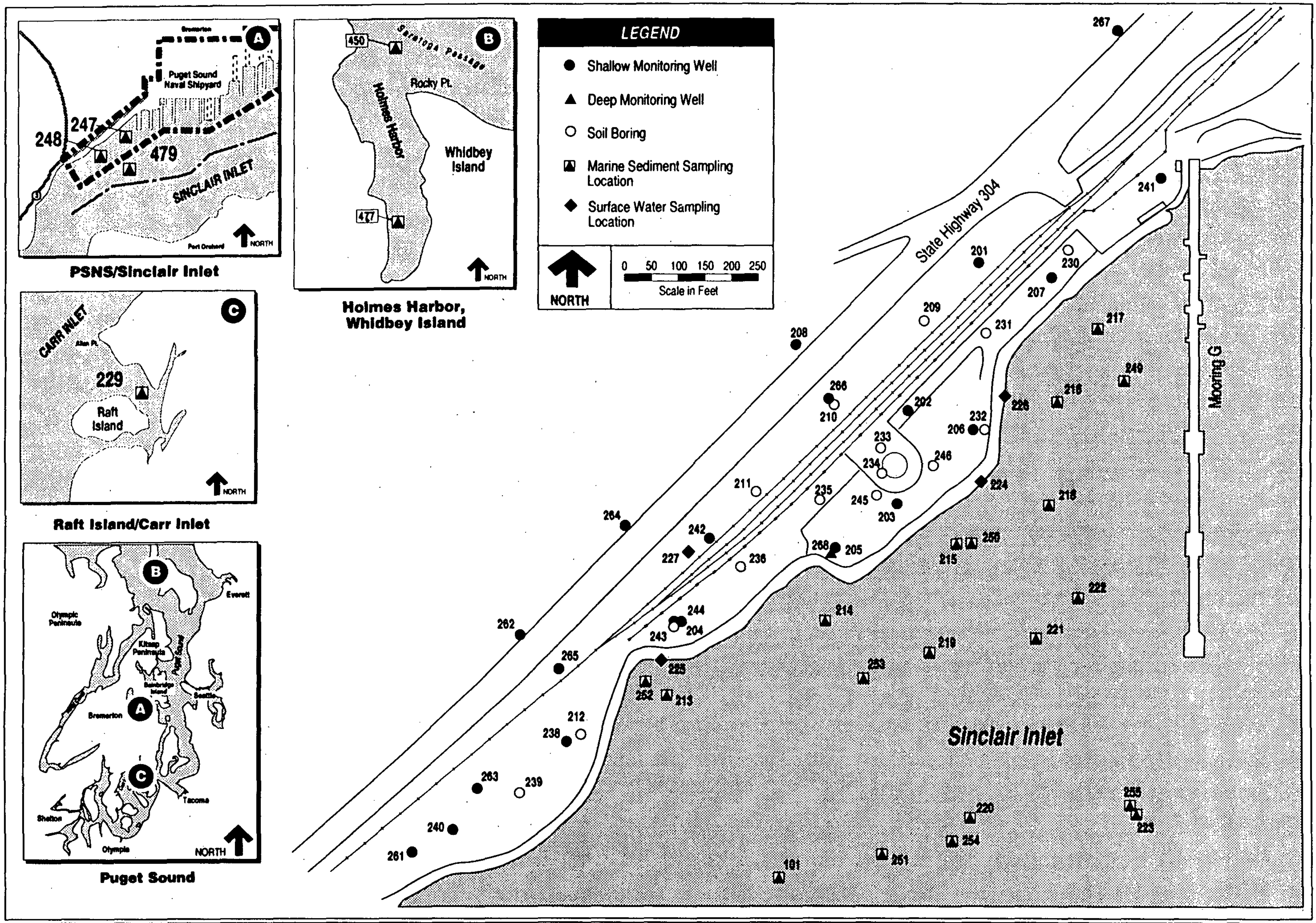

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Figure 6-3
Sampling Locations at Operable Unit A

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Table 6-1
Number and Type of Samples Analyzed From Operable Unit A, by Medium

Matrix	Volatile Organic Compounds	Semivolatile Organic Compounds	Pesticides/Aroclors (PCBs)	PCBs (Only)	Total Inorganics	Dissolved Inorganics	Hexavalent Chromium	Total Petroleum Hydrocarbons (HCID)	Total Petroleum Hydrocarbons (418.1)	Total Petroleum Hydrocarbons—Diesel	Total Petroleum Hydrocarbons—Gasoline	Monofilled Waste Extraction Procedure	Toxicity Characteristics Leaching Procedure	Total Organic Carbon	Organotin	Total Solids	Total Sulfides	AVS/SEM	Bioassay Testing	Total Suspended Solids	Ammonia	Anions	Total
OU A Samples																							
Groundwater	35	36	33	0	36	36	32	23	0	11	7	—	—	23	0	0	0	0	0	23	0	23	318
Surface water	7	7	0	0	7	7	2	2	2	2	2	—	—	2	0	0	0	0	0	0	0	2	42
Surface/near surface soil	15	37	20	7	37	—	0	16	13	9	1	1	1	18	0	—	0	0	0	—	0	—	175
Subsurface soil	65	132	70	35	129	—	2	57	31	25	4	18	18	61	0	0	0	0	0	—	0	—	[illegible]
Marine sediment	35	35	0	35	38	—	0	0	0	0	0	0	0	36	35	36	35	38	3	—	35	—	[illegible]
Background Samples																							
Groundwater	12	10	12	0	14	14	3	0	7	5	2	—	—	2	0	0	0	0	0	2	0	2	85
Soil	40	51	26	0	61	—	0	0	0	0	0	0	0	5	0	—	0	0	0	—	0	—	183
Marine sediment (Carr Inlet)	3	3	0	3	3	—	0	0	0	0	0	0	0	3	3	3	3	3	0	—	3	—	30
Total	212	311	161	80	325	57	39	98	53	52	16	19	19	150	38	39	38	41	3	25	38	27	1,841

Notes:
Totals include field duplicates but not laboratory quality control samples.
Anions include nitrate, nitrite, chloride, and sulfate.
AVS/SEM Acid volatile sulfides/simultaneously extracted metals

Table 6-2
Regulatory Exceedances in OU A Soils

Chemical	Number of Samples	Number of Detections	Maximum Observed Concentration (mg/kg)	MTCA Method A/B[a]	MTCA Method C Industrial/ Method A Industrial[a]
Zone I					
Benzo(a)anthracene	28	18	8.1	• (0.137) [13]	No exceedances
Benzo(a)pyrene	28	19	5	• (0.137) [13]	No exceedances
Benzo(b)fluoranthene	28	23	12	• (0.137) [17]	No exceedances
Benzo(k)fluoranthene	28	23	12	• (0.137) [17]	No exceedances
Chrysene	28	23	4.6	• (0.137) [13]	No exceedances
Dibenz(a,h)anthracene	28	15	1.2	• (0.137) [9]	No exceedances
Indeno(1,2,3-cd)pyrene	28	21	2.1	• (0.137) [13]	No exceedances
Aroclor 1260 (PCBs)	22	1	0.18	• (0.11) [1]	No exceedances
TPH-gasoline	1	1	120	• (Method A[a], 100) [1]	• (Method A Industrial[b], 100) [1]
TPH-diesel	12	12	1,400	• (Method A[a], 200) [5]	• (Method A Industrial[b], 200) [5]
TPH-motor oil (418.1)	15	11	12,000	• (Method A[a] 200) [10]	• (Method A Industrial[b], 200) [10]
Antimony	27	2	48.5	• (32) [1]	No exceedances
Arsenic	27	27	369	• (7.5[c]) [25]	• (188) [1]
Beryllium	27	23	0.61	• (0.6[c]) [20]	No exceedances
Copper	27	27	4,370	• (2960) [3]	No exceedances
Lead	27	27	845	• (Method A, 250)[a] [8]	No exceedances (Method A Industrial[b], 1,000)
TCLP lead	3	3	18.6 mg/L		• (Dangerous waste @ station 261[d], 5 mg/L) below EHW level [1]
Mercury	27	20	333	• (24) [2]	No exceedances

Table 6-2 (Continued)
Regulatory Exceedances in OU A Soils

Chemical	Number of Samples	Number of Detections	Maximum Observed Concentration (mg/kg)	MTCA Method A/B[a]	MTCA Method C Industrial/ Method A Industrial[a]
Zone II					
Benzo(a)anthracene	83	68	20	• (0.137) [59]	• (18) [1]
Benzo(a)pyrene	83	68	11	• (0.137) [59]	No exceedances
Benzo(b)fluoranthene	83	74	19	• (0.137) [69]	• (18) [1]
Benzo(k)fluoranthene	83	74	19	• (0.137) [65]	• (18) [1]
Chrysene	83	70	16	• (0.137) [62]	No exceedances
Dibenz(a,h)anthracene	83	14	1.1	• (0.137) [12]	No exceedances
Indeno(1,2,3-cd)pyrene	83	58	3.9	• (0.137) [41]	No exceedances
bis(2-Ethylhexyl)phthalate	83	24	300	• (71.4) [1]	No exceedances
Aroclor 1242 (PCBs)	69	2	0.4	• (0.11) [2]	No exceedances
Aroclor 1254	69	22	12	• (1.60) [14]	No exceedances
Aroclor 1260 (PCBs)	69	20	1	• (0.11) [12]	No exceedances
PCB-total	69	22	12	• (0.11) [14]	No exceedances
Dieldrin	42	2	0.08	• (0.0625) [1]	No exceedances
TPH-diesel	15	15	1,100	• (Method A[a], 200) [9]	• (Method A Industrial[b], 200) [9]
TPH-motor oil (418.1)	15	14	11,000	• (Method A[a], 200) [12]	• (Method A Industrial[b], 200) [12]
Antimony	80	71	402	• (32) [46]	No exceedances
Arsenic	82	81	1,160	• (7.5[c]) [80]	• (219) [27]
Beryllium	82	76	2.3	• (0.6[c]) [64]	No exceedances
Copper	82	82	19,200	• (2,960) [13]	No exceedances
Lead	82	82	4,940	• (Method A[a], 250) [60]	• (Method A Industrial[b], 1,000) [21]

Table 6-2 (Continued)
Regulatory Exceedances in OU A Soils

Chemical	Number of Samples	Number of Detections	Maximum Observed Concentration (mg/kg)	MTCA Method A/B[e]	MTCA Method C Industrial/ Method A Industrial[e]
Zone II (Continued)					
TCLP lead	10	8	26.5 mg/L	• (Dangerous Waste[d], 5 mg/L) [1]	Below EHW level
Mercury	82	79	1,230	• (24) [1]	• (1,050) [1]
Vanadium	81	80	1,220	• (560) [1]	No exceedances
Zone III					
Benzo(a)anthracene	29	8	0.65	• (0.137) [2]	No exceedances
Benzo(a)pyrene	29	9	0.85	• (0.137) [3]	No exceedances
Benzo(b)fluoranthene	29	9	1.7	• (0.137) [5]	No exceedances
Benzo(k)fluoranthene	29	9	1.7	• (0.137) [5]	No exceedances
Chrysene	29	8	0.74	• (0.137) [3]	No exceedances
Dibenz(a,h)anthracene	29	2	0.21	• (0.137) [1]	No exceedances
Indeno(1,2,3-cd)pyrene	29	6	0.83	• (0.137) [2]	No exceedances
TPH-diesel	2	2	560	• (Method A[a], 200) [2]	• (Method A Industrial[b], 200) [2]
TPH-other	6	4	2,000	• (Method A[a], 200) [2]	• (Method A Industrial[b], 200) [2]
Arsenic	28	28	24.9	• (7.5[c]) [15]	No exceedances

[a]No MTCA Method B cleanup level exists.
[b]No MTCA Method C Industrial cleanup level exists for lead or TPH. Lead and TPH were compared to the MTCA Method A Industrial cleanup level.
[c]PSNS background concentration.
[d]See Washington Dangerous Waste Regulations (WAC 173-303-090).
[e]Number in brackets refers to number of regulatory exceedances.

Table 6-2 (Continued)
Regulatory Exceedances in OU A Soils

Notes:

•	Exceedance
EHW	Extremely hazardous waste
MTCA	Model Toxics Control Act
PCB	Polychlorinated biphenyl
TCLP	Toxicity characteristics leaching procedure
TPH	Total petroleum hydrocarbon

Table 6-3
Regulatory Exceedances of Marine Surface Water Standards and Background in OU A Groundwater

Chemical	Number of Samples	Number of Detections	Maximum Concentration (µg/L)	Human Health Fish Ingestion: MTCA Method B	Human Health Fish Ingestion: National Toxics Rule	Marine Organisms: State Marine (201A)	Marine Organisms: Federal Marine Water Quality
Zone I							
Dissolved arsenic	4	1	29.9	•/• (7.6^b/17.7) [1]/[1]	• (7.6^b) [1]	Below	Below
Dissolved beryllium	4	1	0.6	•/ (0.079/) [1]/			
Dissolved copper	4	1	12.4	Below		• (2.85^b) [1]	• (2.9) [1]
Zone II							
Benzo(a)anthracene	17	6	33	• (0.0296) [6]	• (0.031) [6]		
Benzo(a)pyrene	17	5	28	• (0.0296) [5]	• (0.031) [5]		
Benzo(b)fluoranthene	17	6	43	• (0.0296) [6]	• (0.031) [6]		
Benzo(k)fluoranthene	17	6	43	• (0.0296) [6]	• (0.031) [6]		
Chrysene	17	6	37	• (0.0296) [6]	• (0.031) [6]		
Indeno(1,2,3-cd)pyrene	17	3	13	• (0.026) [3]	• (0.031) [3]		
BEHP	17	16	130	•/ (3.56/) [6]	• (5.9) [3]		
Aldrin	15	3	0.32	•/• (0.0000816/0.0167) [3]/[3]	• (0.00014) [3]	• (0.0019) [3]	Below
Dieldrin	15	1	0.0013	•/ (0.0000867) [1]/	• (0.00014) [1]	Below	Below
Endrin	15	2	0.021	Below	Below	• (0.0023) [2]	• (0.0023) [2]
Heptachlor epoxide	15	1	0.06	•/• (0.0000636/0.00301) [1]/[1]	• (0.00011) [1]		• (0.0036) [1]

Table 6-3 (Continued)
Regulatory Exceedances of Marine Surface Water Standards and Background in OU A Groundwater

Chemical	Number of Samples	Number of Detections	Maximum Concentration (μg/L)	Human Health Fish Ingestion: MTCA Method B	Human Health Fish Ingestion: National Toxics Rule	Marine Organisms: State Marine (201A)	Marine Organisms: Federal Marine Water Quality
Zone II (Continued)							
alpha-Chlordane	15	1	0.001	•/ (0.000354/) [1]/	• (0.00059) [1]	Below	Below
gamma-Chlordane	15	4	0.011	•/• (0.000354/0.011) [4]/[1]	• (0.00059) [1]	• (0.004) [1]	• (0.004) [1]
4,4-DDD	15	5	0.12	• (0.000504) [5]	• (0.00084) [5]	• (0.001) [5]	
4,4-DDE	15	1	0.035	• (0.000356) [1]	• (0.00059) [1]	• (0.001) [1]	
4,4-DDT	15	1	0.06	•/• (0.000356/0.0242) [5]/[1]	• (0.00059) [5]	• (0.001) [5]	• (0.001) [5]
Aroclor 1260 (PCBs)	15	3	1.3	• (0.000027) [3]	•(0.000045) [3]	• (0.03) [3]	• (0.03) [3]
Dissolved arsenic	17	12	1,200	•/• (7.6[b]/17.7) [12]/[6]	• (7.6[b]) [12]	• (36) [6]	• (36) [6]
Dissolved copper	17	5	110	Below		• (2.85[b]) [5]	• (2.9) [5]
Dissolved nickel	17	8	249	Below	Below	• (10.4[b]) [7]	• (10.4[b]) [7]
Dissolved silver	17	1	11.3	Below		• (1.2) [1]	• (2.3) [1]
Dissolved thallium	17	2	10	• (1.56) [2]	• (6.3) [2]		

Table 6-3 (Continued)
Regulatory Exceedances of Marine Surface Water Standards and Background in OU A Groundwater

Chemical	Number of Samples	Number of Detections	Maximum Concentration (µg/L)	Human Health Fish Ingestion: MTCA Method B	Human Health Fish Ingestion: National Toxics Rule	Marine Organisms: State Marine (201A)	Marine Organisms: Federal Marine Water Quality
Zone II (Continued)							
Dissolved zinc	17	8	602	Below		• (76.6) [4]	• (86) [4]
Zone III							
Dissolved beryllium	6	1	0.3	•/ (0.079/) [1]/			
Dissolved copper	6	1	6.4	Below		• (2.85[b]) [1]	• (2.9) [1]
Dissolved mercury	6	1	1.4		• (0.15) [1]	• (0.025) [1]	• (0.025) [1]

[a]Due to the increased turbidity in the SI and Phase I sampling rounds, only total inorganics from the Phase II sampling round are considered when low-flow sampling techniques were used to limit turbidity in the collected sample.
[b]Surface water standard is below ambient level for groundwater.
[c]Numbers in [ ] indicate number of regulatory exceedances.

Notes:
- • Detected above potential surface water regulatory requirements and ambient groundwater.
- •/ Detected above MTCA carcinogenic criteria but below MTCA noncarcinogenic criteria.
- •/• Detected above MTCA carcinogenic and noncarcinogenic criteria.

Table 6-3 (Continued)
Regulatory Exceedances of Marine Surface Water Standards and Background in OU A Groundwater

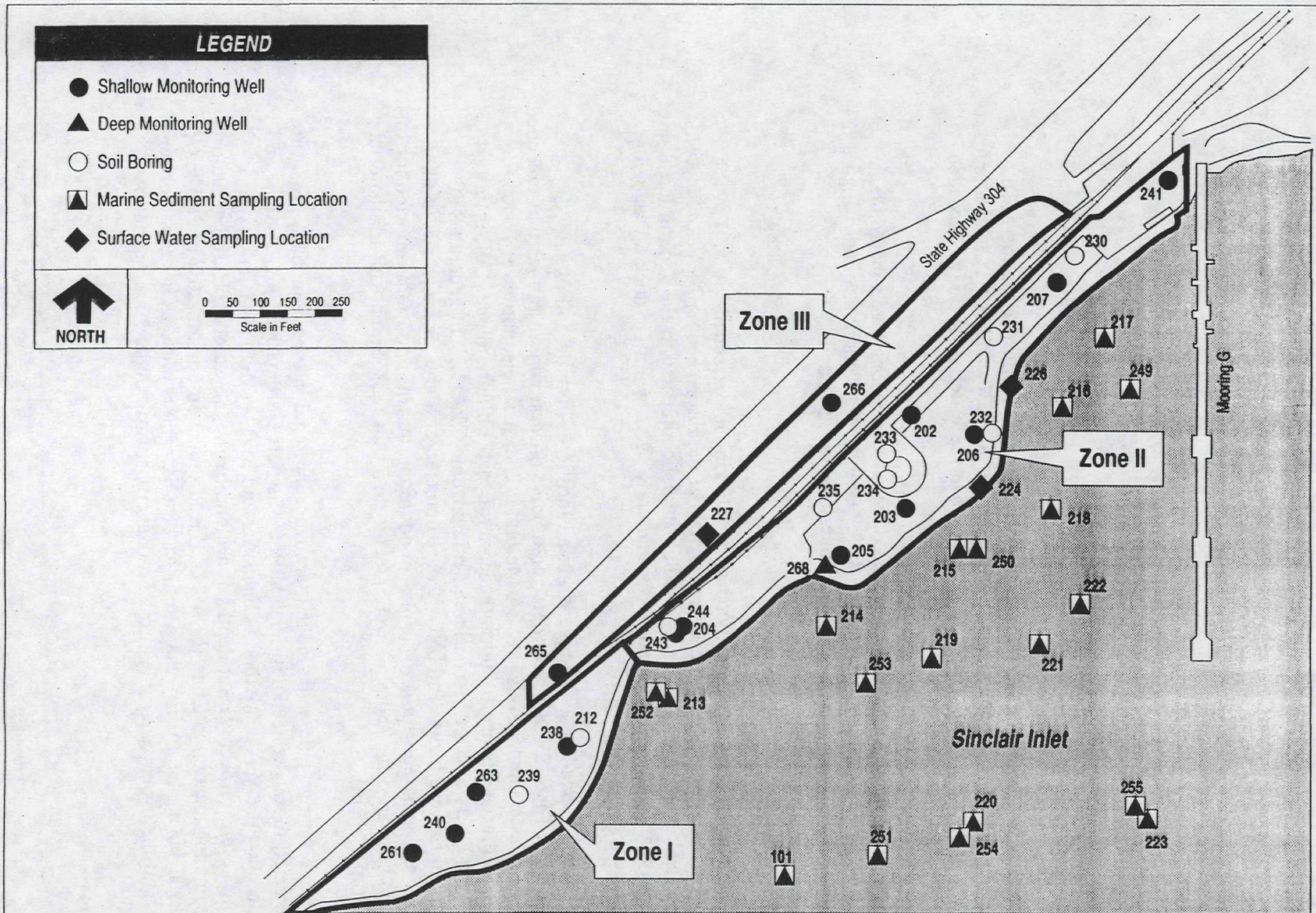
Shading	No standard exists for the chemical under this potential regulatory requirement.
Below	Concentration of this chemical was below level of concern.
MTCA Method B	Surface water human health-based cleanup levels (Ecology 1996).
Clean Water Act	Marine chronic criteria for protection of aquatic life under the federal Clean Water Act.
National Toxics Rule	10^{-6} human health risk for carcinogens from consumption of organisms only (federal Clean Water Act 40 CFR 131.36 (b)(1)).
State marine chronic (201A)	Marine chronic criteria for protection of aquatic life under Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201A-040).

Table 6-4
Regulatory Exceedances in OU A Surface Water

Chemical	Number of Samples	Number of Detections	Maximum Observed Concentration (µg/L)	Chronic Federal Marine Water Quality Criteria	State 201A Marine Chronic
Zone II					
Total arsenic	4	1	7.5	Below	Below
Dissolved arsenic	4	3	7.4	Below	Below
Total copper	4	1	26.5	• (2.9) [1][a]	• (2.5) [1]
Dissolved copper	4	1	17.6	• (2.9) [1]	• (2.5) [1]
Total nickel	4	3	263.0	• (8.3) [3]	• (7.9) [3]
Dissolved nickel	4	3	279.0	• (8.3) [3]	• (7.9) [3]
Total zinc	4	2	108.0	• (86) [1]	• (76.6) [1]
Dissolved zinc	4	2	180.0	• (86) [1]	• (76.6) [1]
Zone III					
Total copper	1	1	17.3	• (2.9) [1]	• (2.5) [1]
Dissolved copper	1	1	15.3	• (2.9) [1]	• (2.5) [1]

[a]Numbers in [ ] indicate number of regulatory exceedances.

Note:
Below Indicates below the existing standard.



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 6-4** **Locations Where Contamination Exceeded Screening Levels**	CTO 0160 PSNS OU A Bremerton, Washington FINAL ROD

533160014-4-112096

6.7.1 Soil Contaminants

Zone I

Soil samples collected from the Charleston Beach parking lot exceeded the MTCA Method C Industrial screening levels for arsenic (at MW238) and the TCLP standard for lead (at a "hotspot" at station 261) at depths above the water table. TPH exceeded MTCA A screening levels at most locations

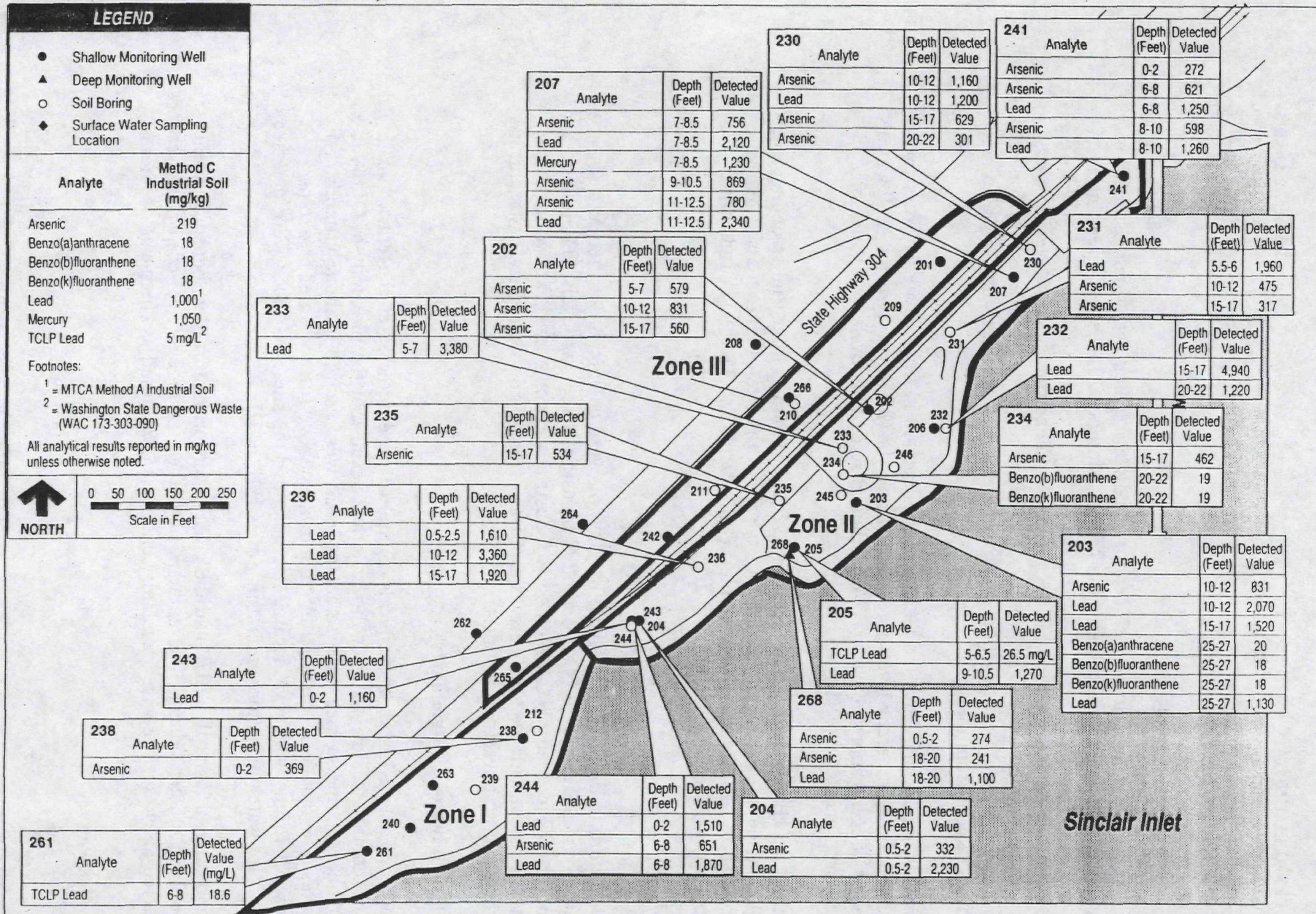
No VOCs or PCBs were detected in excess of MTCA screening levels in samples collected from Charleston Beach during the 1993 and 1994 sampling rounds. Figure 6-5 summarizes the exceedances of MTCA C industrial levels in soils.

Zone II

Soil samples collected from the helicopter pad parking lot exceeded the MTCA Method C Industrial screening levels for cPAHs at depths exceeding 20 feet. Polycyclic aromatic hydrocarbons (PAHs) are found at the helicopter pad in the general location of a burn pit that operated in the late 1950s and early 1960s while Drydock 6 was being constructed.

SVOCs were detected in soil samples from all locations, both on and off site (upgradient). Three SVOCs were detected at least once at concentrations that exceeded the applicable screening levels (MTCA Method C Industrial cleanup levels): benzo(a)anthracene, benzo(b)fluoranthene, and benzo(k)fluoranthene. All of these SVOCs are PAHs of the type considered carcinogenic (cPAHs). In general, SVOC concentrations were higher and SVOCs were detected at a greater frequency in fill materials as compared with native soils. In addition, the concentrations reported for on-site samples nearest the shoreline were greater than those associated with fill material off site (upgradient).

The arsenic, copper, lead, and zinc that are typically found in spent sandblast grits were also detected in soils collected throughout the Missouri Gate parking lot. Arsenic and lead exceeded the MTCA Method C Industrial and MTCA Method A Industrial screening levels, respectively, at depths above and below the water table and at almost every sampling location in Zone II. A TCLP lead detection (station 205) of 26.5 mg/L qualifies as having the toxicity characteristics of a hazardous waste as described under RCRA and the toxicity characteristics of a dangerous waste under state regulations



Analyte	Method C Industrial Soil (mg/kg)
Arsenic	219
Benzo(a)anthracene	18
Benzo(b)fluoranthene	18
Benzo(k)fluoranthene	18
Lead	1,000[1]
Mercury	1,050
TCLP Lead	5 mg/L[2]

207

Analyte	Depth (Feet)	Detected Value
Arsenic	7-8.5	756
Lead	7-8.5	2,120
Mercury	7-8.5	1,230
Arsenic	9-10.5	869
Arsenic	11-12.5	780
Lead	11-12.5	2,340

230

Analyte	Depth (Feet)	Detected Value
Arsenic	10-12	1,160
Lead	10-12	1,200
Arsenic	15-17	629
Arsenic	20-22	301

241

Analyte	Depth (Feet)	Detected Value
Arsenic	0-2	272
Arsenic	6-8	621
Lead	6-8	1,250
Arsenic	8-10	598
Lead	8-10	1,260

202

Analyte	Depth (Feet)	Detected Value
Arsenic	5-7	579
Arsenic	10-12	831
Arsenic	15-17	560

231

Analyte	Depth (Feet)	Detected Value
Lead	5.5-6	1,960
Arsenic	10-12	475
Arsenic	15-17	317

233

Analyte	Depth (Feet)	Detected Value
Lead	5-7	3,380

232

Analyte	Depth (Feet)	Detected Value
Lead	15-17	4,940
Lead	20-22	1,220

235

Analyte	Depth (Feet)	Detected Value
Arsenic	15-17	534

234

Analyte	Depth (Feet)	Detected Value
Arsenic	15-17	462
Benzo(b)fluoranthene	20-22	19
Benzo(k)fluoranthene	20-22	19

236

Analyte	Depth (Feet)	Detected Value
Lead	0.5-2.5	1,610
Lead	10-12	3,360
Lead	15-17	1,920

203

Analyte	Depth (Feet)	Detected Value
Arsenic	10-12	831
Lead	10-12	2,070
Lead	15-17	1,520
Benzo(a)anthracene	25-27	20
Benzo(b)fluoranthene	25-27	18
Benzo(k)fluoranthene	25-27	18
Lead	25-27	1,130

205

Analyte	Depth (Feet)	Detected Value
TCLP Lead	5-6.5	26.5 mg/L
Lead	9-10.5	1,270

243

Analyte	Depth (Feet)	Detected Value
Lead	0-2	1,160

268

Analyte	Depth (Feet)	Detected Value
Arsenic	0.5-2	274
Arsenic	18-20	241
Lead	18-20	1,100

238

Analyte	Depth (Feet)	Detected Value
Arsenic	0-2	369

244

Analyte	Depth (Feet)	Detected Value
Lead	0-2	1,510
Arsenic	6-8	651
Lead	6-8	1,870

204

Analyte	Depth (Feet)	Detected Value
Arsenic	0.5-2	332
Lead	0.5-2	2,230

261

Analyte	Depth (Feet)	Detected Value (mg/L)
TCLP Lead	6-8	18.6

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Figure 6-5
Exceedances of MTCA Method C Industrial Screening Levels for Soil (Excludes TPH)

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(WAC 173-303-090). Mercury, which is not typically associated with sandblast grits, was also detected at a concentration above the MTCA Method C Industrial screening level.

TPH concentrations exceeded the MTCA Method A Industrial cleanup levels at every station sampled during 1994. The presence of TPH is likely due to the use of Zone II as an unpaved parking lot prior to April 1995. A gas station and major highway also are located upgradient from the site.

Aroclors 1242, 1254, and 1260 and dieldrin were detected in fill at levels in excess of MTCA Method B screening levels throughout Zone II. (However, Aroclor 1260 was also detected at concentrations above MTCA Method B screening levels in off-site soils collected from across State Highway 304.)

Inorganics and cPAHs detected in excess of MTCA Method C Industrial screening levels roughly coincide in extent with the depth of the fill at the site. Figure 6-5 summarizes the exceedances of relevant MTCA Method C Industrial and Method A Industrial screening levels in soils for Zone II.

Zone III

At no locations in Zone III, the upland parking lot, were chemicals detected at concentrations in excess of MTCA Method C Industrial screening levels. TPH-diesel and TPH-motor oil exceeded MTCA Method A Industrial screening levels at two locations, which is consistent with the area's use as a railyard from 1946 to the early 1980s and its recent history as a paved parking lot.

6.7.2 Groundwater Contaminants

As shown in Table 6-3, several chemicals of interest were detected at concentrations in excess of federal and state water quality criteria. Because of the proximity of OU A to Sinclair Inlet, marine surface water screening levels were used to evaluate groundwater at the site. The only VOC detected in groundwater above surface water screening criteria was benzene, which was located upgradient of the site. No VOCs were detected above surface water regulatory criteria in Zones I, II, or III.

In groundwater in Zone II, BEHP and the cPAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene were all detected above surface water regulatory criteria and retained as chemicals of interest in groundwater. BEHP was also detected above surface water regulatory criteria upgradient of the site in a boundary control well.

Aroclor 1260 and the pesticides aldrin, dieldrin, endrin, heptachlor epoxide, alpha-chlordane, gamma-chlordane, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT were retained as chemicals of interest in groundwater in Zone II based on the exceedances of surface water regulatory criteria.

Total metals of interest (i.e., metals in unfiltered samples) found in groundwater at OU A are arsenic, beryllium, copper, lead, mercury, thallium, and zinc. Each of these metals exceeded marine surface water regulatory criteria.

Dissolved metals of interest (i.e., metals in filtered samples) found in groundwater at OU A are arsenic, beryllium, copper, nickel, silver, thallium, and zinc. Each of these metals exceeded marine surface water regulatory criteria.

Groundwater Seep Contamination

The seep in Zone II that was sampled in 1993 and 1994 represents the sampling station (224) located closest to the point at which groundwater enters Sinclair Inlet. Results from the seep samples were compared to surface water standards. Dissolved and total arsenic, copper, nickel, and zinc were found to exceed either the MTCA Method B screening levels for surface water or state and federal chronic marine water standards.

Concentrations of total and dissolved inorganics observed in the seep (arsenic, copper, nickel, and zinc) and the nearshore monitoring wells (arsenic, copper, lead, nickel, silver, thallium, and zinc) were similar, suggesting that the seep represents groundwater visible at the periphery of the site.

To evaluate groundwater fate and transport, modeling of OU A Zone II at PSNS was conducted in two phases (URS 1996a). Flow rates were estimated to be approximately 300 gallons per day per foot. Fate and transport modeling of arsenic, a chemical found in all media at the site, suggests an upper bound flux rate of approximately 16 kg/yr from the fill in Zone II to Sinclair Inlet.

6.7.3 Surface Water Contaminants

Surface water samples collected in 1993 from stations 225, 226, and 227 are representative of stormwater runoff from the paved upper parking lot in Zone III. Dissolved arsenic, total and dissolved copper, and total and dissolved nickel in these samples exceeded federal and state AWQC; no additional catch basin samples were collected in 1994.

No VOCs were detected in surface water in seeps or stormwater basin samples.

BEHP was the only SVOC detected in excess of the applicable MTCA Method B cleanup level or the federal AWQC. BEHP was detected at a concentration of 5 J μg/L at one location.

Stormwater sampling of runoff from parking lots and other sources is conducted under the NPDES permitting and monitoring process for PSNS. However, no outfalls at OU A have specified sampling requirements. Table 6-4 and Figure 6-4 summarize all exceedances of regulatory criteria in surface water. Surface water issues will be addressed under a basewide surface water management program. New storm drains were installed at OU A in 1995.

6.7.4 Marine Sediment Contaminants

The following discussion of marine resources is provided for information only. Marine resources are not addressed under this ROD. However, a summary of marine sampling is included since this ROD does address chemicals in soils and groundwater that have the potential to affect marine resources.

Two rounds of marine sediment sampling were conducted near OU A. Maximum concentrations of detected compounds in marine sediment were compared to the marine SQS and cleanup screening levels (CSLs) under the Washington State SMS (WAC 173-204). The state SQS for marine sediments address only protection of aquatic organisms and not bioaccumulation of toxics and subsequent ingestion by humans. The CSLs establish adverse effects and are the levels above which locations of potential concern are defined.

Concentrations of six inorganics (arsenic, cadmium, copper, lead, mercury, and zinc) exceeded the CSLs outlined in the Washington State SMS (WAC 173-204). In addition, the first subsurface stratum (5 to 25 centimeters) at station 222 exhibited high concentrations of PAHs, including 10 compounds for which concentrations exceeded the CSLs.

Mercury was detected in all samples and at all locations in Sinclair Inlet that were sampled for OU A. The highest concentration was 12.3 mg/kg at station 213 and the lowest detected concentration was 0.33 mg/kg; both the highest and lowest concentrations occurred in the first subsurface stratum. The surface stratum concentrations of mercury were generally higher in the west and lower in the east. Mercury concentrations exceeded the CSL at all 21 test stations in Sinclair Inlet.

Copper was detected in all samples and at all locations in Sinclair Inlet that were sampled for OU A. The highest concentration was 3,040 mg/kg in the first subsurface stratum at station 219, and the lowest concentration was 35.4 mg/kg in the deepest stratum at station 220. Copper concentrations exceeded the CSL at 8 of 19 stations where copper was measured, primarily in the south and west portions of the marine environment at OU A.

Detections of zinc were observed in all sediment samples and at all locations in Sinclair Inlet that were sampled for OU A. The highest concentration of zinc was 4,010 mg/kg in the first subsurface stratum at station 213, and the lowest concentration was 105 mg/kg in the lowest stratum at station 221. Zinc concentrations exceeded the CSL at 7 of 19 stations where zinc was measured, primarily in the south and west portions of the marine environment at OU A.

Lead was detected in all samples and at all locations sampled in Sinclair Inlet for OU A. The highest concentration of lead was measured in the first subsurface stratum at station 213 (1,280 mg/kg), and the lowest concentration was measured in the lowest stratum at station 221 (33.6 mg/kg). Lead concentrations exceeded the CSL at 7 of 19 stations where the measurements were made, primarily in the south and west portions of the marine environment at OU A.

Arsenic was detected in a total of 30 of 35 samples and at all locations sampled in Sinclair Inlet for OU A. The high value was observed in the southern portion of OU A, and station 214 concentrations were low compared to the concentrations of other metals. Arsenic was not detected in two strata at each of two stations. Only station 220 measured a CSL exceedance for arsenic.

Cadmium was detected in a total of 16 of 35 samples and at 11 of 19 locations sampled in Sinclair Inlet for OU A. Cadmium in the surface stratum showed the highest concentration in the western portion of OU A. Cadmium was not detected in the surface stratum at 10 stations. Only station 213 exceeded the CSL for cadmium.

One "hotspot" contaminated with SVOCs, particularly PAHs, was detected off Mooring G at station 222. The highest chemical concentrations and the greatest number of exceedances were observed in (1) the western corner, (2) the northern corner, (3) the southern edge, and (4) the central region of OU A.

Subtidal Bioassays and Tissue

The marine habitat of OU A is dominated by subtidal habitat. Results of the sediment chemistry comparisons to sediment quality values (SQVs) (which represent sediment concentrations below which adverse impacts are unlikely) show that chlordane, copper, DDT and metabolites, lead, mercury, nickel, PCBs, and zinc present high priority risks, while antimony, arsenic, cadmium, PAHs, and phthalate esters present medium priority risks. Bioassays using three test organisms tested at two sampling stations in OU A showed no adverse effects.

Tissue data from mussels and clams were compared with maximum acceptable tissue concentrations. Results suggest that chromium, lead, nickel, selenium, and zinc present risks to shellfish populations.

7.0 SUMMARY OF SITE RISKS

A baseline risk assessment was conducted to evaluate both current and potential future risks at OU A. The assessment serves as a baseline to indicate the risks that could exist if no action were taken and takes into consideration possible risks if existing land use patterns shift in the future to other uses, such as residential. The results of the risk assessment are used in evaluating whether remedial action is needed. The ecological risk assessment was qualitative and consisted of habitat characterization, hazard identification, exposure assessment, dose-response relationship, and risk characterization.

A baseline risk assessment is required under CERCLA. The human health and ecological risk assessments were prepared in accordance with EPA guidance documents. MTCA establishes cleanup goals for soil, water, and air based on human health risks. However, the CERCLA approach to human health risk assessment is different from the MTCA method used to determine screening levels. Risk assessments based on EPA guidance evaluate dermal contact as an exposure pathway, whereas MTCA does not. In addition, the MTCA method for residential exposure focuses on exposures to young children, while EPA guidance considers exposure over a 30-year period.

7.1 HUMAN HEALTH RISK ASSESSMENT

The human health risk assessment in the RI evaluated potential risks associated with exposure to chemical contaminants detected at OU A. Possible future uses include activities such as shellfishing and fishing. Risks were therefore calculated for five exposure scenarios: current transit walker, current utility worker, future industrial worker, hypothetical future resident, and future shellfish harvester/fisher. These scenarios were chosen to evaluate potential cases for human exposure. A current on-site resident was not considered because no one lives at the site.

The current transit-walker scenario was developed consistent with OU A's current use as a parking lot. Therefore, the only route of exposure is inhaling particulates.

Routes of exposure evaluated for current utility workers included ingestion of, and dermal contact with, soil and inhalation of particulates. Exposure to surface water or sediment is not included in this scenario, because there is no opportunity for a utility worker to come into contact with these media.

Routes of exposure evaluated under the future industrial worker scenario include ingestion of chemicals in soil, inhalation of airborne particulates, and dermal contact with chemicals in soil. An adult was used to evaluate this scenario.

Potential exposure routes to the future resident include ingestion of chemicals in soil, inhalation of airborne particulates, and dermal contact with chemicals in soil. Groundwater ingestion was not considered because of its high salinity (non-potability).

Routes of exposure evaluated under the shellfish harvesting and fishing scenarios include ingestion of seafood (either shellfish or fish) and, for the shellfish harvesting scenario, potential for ingestion of and dermal contact with sediments while digging for shellfish. Contact with sediment under the fishing scenario was not evaluated because exposure to soil or sediment is assumed not to occur. For the boater, direct exposure to soil or sediment is not a potential exposure pathway. For the shore angler, soil and sediment exposures are not considered pathways of exposure because the optimal shore angling fishing time is at high tide, when soil and sediments are not exposed. An adult was used to evaluate these scenarios. A summary of exposure pathways evaluated in the RI is included in Table 7-1.

The primary components of the human health risk assessment are data evaluation, toxicity assessment, exposure assessment, and risk characterization, which are discussed in the following subsections.

7.1.1 Data Evaluation

The analytical results for each medium were evaluated to identify a list of chemicals, referred to as chemicals of potential concern (COPCs), to be carried through the remainder of the risk assessment. This list of COPCs was established by evaluating the following factors:

- **Data quality.** Data rejected because of inadequate quality were eliminated from further consideration. This involved only 2 percent of the data and there were no systematic effects on the utility of the data that resulted.

Table 7-1
Human Exposure Pathways Used to Evaluate Potental Risks From Chemicals at OU A

Medium	Current Transit Walker			Current Utility Worker			Future Industrial Worker			Hypothetical Future Resident			Future Shellfish Harvester/Fisher		
	ING	INH	DC	ING	INH	DC	ING	INH	DC	ING	INH	DC	ING	INH	DC
Soil		•		•	•	•	•	•	•	•	•	•			
Sediment															•[a]
Fish/shellfish													•		

[a]Considered for shellfish harvester only.

Notes:
Exposure pathways not selected (indicated by the absence of a bullet) for detailed evaluation were judged to represent incomplete pathways.
• Exposure model evaluated for the population and medium indicated.
DC Dermal contact
ING Ingestion
INH Inhalation

- **Essential nutrients.** Chemicals considered essential nutrients and generally nontoxic (e.g., aluminum, calcium, iron) were eliminated from further consideration.

- **Background concentrations.** Inorganic chemicals with site concentrations below background concentrations were eliminated.

- **Frequency of detection.** Chemicals detected in less than 5 percent of the total samples for a medium were eliminated from further consideration.

- **Laboratory contamination.** Chemicals identified as common laboratory contaminants were eliminated if concentrations were less than 10 times the laboratory blank value. Chemicals not identified as common laboratory contaminants were eliminated if concentrations were less than 5 times the laboratory blank value.

- **Upgradient chemicals.** Butylbenzylphthalate was the only chemical in soil that was found upgradient of the site; therefore, it was excluded from the risk assessment.

A list of the COPCs identified for surface and subsurface soils and marine sediment at OU A are presented in Tables 7-2 through 7-7.

7.1.2 Toxicity Assessment

A toxicity assessment was conducted for the COPCs to measure the relationship between the magnitude of exposure and the likelihood or severity of adverse effect (i.e., dose-response assessment) on exposed populations. Toxicity values are used to express the dose-response relationship and are developed separately for carcinogenic (cancer-causing) effects and noncarcinogenic (noncancer-causing) health effects. Toxicity values are derived from either epidemiological or animal studies, to which uncertainty factors are applied. These uncertainty factors account for variability among individuals, as well as for the use of animal data to predict effects on humans. The primary sources for toxicity values are the EPA's Integrated Risk Information System (IRIS) database and its Health Effects Assessment Summary Table (HEAST). Both IRIS and HEAST were used to identify the toxicity values used in the risk assessment.

Table 7-2
Reasonable Maximum Exposure and Average Exposure Point Concentrations in Soil for OU A: Current Worker

Chemical	RME Concentration (mg/kg)	Average Concentration (mg/kg)
Soil - Inorganics		
Antimony	58.1	42.0
Arsenic	110	79.9
Barium	403	303
Beryllium	0.58	0.49
Cadmium	3.2	2.6
Chromium	120	97.3
Copper	1,390	1,070
Lead	611	477
Manganese	820	645
Mercury	16.4	7.9
Vanadium	112	79.6
Soil - Organics		
Aroclor 1242	0.048	0.035
Aroclor 1254	0.93	0.49
Aroclor 1260	0.16	0.11
Benzo(a)anthracene	1.4	0.94
Benzo(a)pyrene	1.1	0.77
Benzo(b)fluoranthene	1.7	1.3
Benzo(k)fluoranthene	1.7	1.2
delta-BHC	0.0025	0.0020
4,4'-DDD	0.087	0.045
Dibenzo(a,h)anthracene	1.2	0.84
Dieldrin	0.0086	0.0055
Bis(2-ethylhexyl)phthalate	15.3	7.1
Heptachlor	0.0031	0.0023
Indeno(1,2,3-cd)pyrene	1.2	0.78
4-Methylphenol	0.074	0.074
TPH-diesel	500	306
TPH-gasoline	23	14
TPH-motor oil	80	62

Notes:
Air concentrations (mg/m^3) can be derived from soil concentrations by dividing by the particulate emission factor of 4.69×10^9 m^3/kg.
RME Reasonable maximum exposure

Table 7-3
Reasonable Maximum Exposure and Average Exposure Point Concentrations in Soil for OU A: Transit-Walker

Chemical	RME Concentration (mg/kg)	Average Concentration (mg/kg)
Soil - Inorganics		
Antimony	67.3	43.6
Arsenic	109	77.8
Barium	560	384
Beryllium	0.68	0.53
Cadmium	3.7	2.8
Chromium	130	97.5
Copper	1,580	1,060
Lead	617	455
Manganese	1,140	807
Mercury	29.6	12.5
Vanadium	85.9	65.3
Soil - Organics		
Aroclor 1254	1.5	0.69
Aroclor 1260	0.25	0.16
Benzo(a)anthracene	0.57	0.43
Benzo(a)pyrene	0.65	0.49
Benzo(b)fluoranthene	0.96	0.72
Benzo(k)fluoranthene	0.94	0.70
Dibenzo(a,h)anthracene	0.21	0.21
Heptachlor	0.0043	0.0024
Indeno(1,2,3-cd)pyrene	0.53	0.41

Notes:
Air concentrations (mg/m^3) can be derived from soil concentrations by dividing by the particulate emission factor of 4.63×10^9 m^3/kg.
RME Reasonable maximum exposure

Table 7-4
Reasonable Maximum Exposure and Average Exposure Point Concentrations in Soil at OU A: Future Resident and Future Worker

Chemical	RME Concentration (mg/kg)	Average Concentration (mg/kg)
Soil - Inorganics		
Antimony	72.0	55.5
Arsenic	165	126
Barium	415	327
Beryllium	0.53	0.46
Cadmium	4.1	3.4
Chromium	116	98.4
Copper	1,980	1,500
Lead	633	517
Manganese	766	639
Mercury	38.6	17.8
Nickel	99.0	81.7
Vanadium	92.2	71.4
Zinc	2,360	1,940
Soil - Organics		
Aroclor 1242	0.043	0.034
Aroclor 1254	0.67	0.38
Aroclor 1260	0.13	0.10
Benzo(a)anthracene	1.2	0.87
Benzo(a)pyrene	1.0	0.75
Benzo(b)fluoranthene	1.6	1.2
Benzo(k)fluoranthene	1.6	1.2
delta-BHC	0.0022	0.0018
Carbazole	0.47	0.35
4,4'-DDD	0.064	0.035
Dibenzo(a,h)anthracene	0.93	0.67
Dieldrin	0.0069	0.0047
Bis(2-ethylhexyl)phthalate	9.8	4.7
Heptachlor	0.0026	0.0020
Indeno(1,2,3-cd)pyrene	0.94	0.68

Table 7-4 (Continued)
Reasonable Maximum Exposure and Average Exposure Point Concentrations in Soil at OU A: Future Resident and Future Worker

Chemical	RME Concentration (mg/kg)	Average Concentration (mg/kg)
4-Methylphenol	0.71	0.69
TPH-diesel	412	274
TPH-gasoline	19	14
TPH-motor oil	100	56

Notes:
Air concentrations (m^3/mg) for the inhalation route of exposure are derived from soil concentrations by multiplying by the particulate emission factor of 4.63×10^9 m^3/kg.
RME Reasonable maximum exposure

Table 7-5
Exposure Point Concentrations in Shellfish Tissue for Shellfish Harvester at OU A

Chemical	Exposure Point Concentration (mg/kg)[a]
Aroclor 1254	0.02
Chromium VI	1.2
Dibutyltin dichloride	0.003
Lead	0.37
Mercury	0.02
Nickel	0.99
Selenium	1.0
Zinc	20.3

[a]RME concentration

Table 7-6
Exposure Point Concentrations in Intertidal Sediment
Used for Shellfish Harvester at OU A

Chemical	Exposure Point Concentration (mg/kg)[a]
Antimony	19.8
Aroclor 1254	0.35
Aroclor 1260	0.84
Arsenic	50.7
Benzo(a)anthracene	1.1
Benzo(a)pyrene	0.80
Benzo(b)fluoranthene	1.8
Benzo(k)fluoranthene	1.8
Chromium VI	112
Copper	974
DDT	0.53
Dibenzo(a,h)anthracene	0.23
Indeno(1,2,3-cd)pyrene	0.39
Lead	634
Mercury	4.2

[a]RME concentration

Table 7-7
Exposure Point Concentrations in Fish Tissue Used for Fisher at OU A

Chemical	Exposure Point Concentration (mg/kg)[a]
Aldrin	0.0010
Aroclor 1260	0.14
Bis(2-ethylhexyl)phthalate	0.64
alpha-Chlordane	0.0020
gamma-Chlordane	0.0016
Chromium VI	0.16
DDE	0.0034
Endosulfan II	0.004
Endosulfan sulfate	0.004
Heptachlor	0.002
Lead	0.1
Mercury	0.036

[a]Reasonable maximum exposure (RME)

Toxicity values for carcinogenic effects are referred to as cancer slope factors (SFs). SFs have been developed by the EPA to estimate excess lifetime cancer risks associated with exposure to potential carcinogens (cancer-causing chemicals). SFs are expressed in units of $(mg/kg/day)^{-1}$. SFs are multiplied by the estimated daily intake rate of a potential carcinogen to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The upper-bound estimate reflects the conservative estimate of risks calculated from the SF. This approach makes underestimation of the actual cancer risk highly unlikely.

Toxicity values for noncancer effects are termed reference doses (RfDs). RfDs are expressed in units of mg/kg/day. RfDs are estimates of acceptable lifetime daily exposure levels for humans, including sensitive individuals. Estimated intakes of COPCs (e.g., the amount of a chemical that might be ingested from contaminated drinking water) are compared with the RfDs to assess risk.

Reference doses were not available for the following 13 chemicals detected at OU A: Aroclors 1242 and 1260, benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, 4,4′-DDD, delta-BHC, copper, lead, and petroleum hydrocarbons.

Published RfDs have not been identified for the following 10 compounds: Aroclors 1242 and 1260, benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, 4,4′-DDD, and delta-BHC. However, cancer risks were computed for these chemicals.

Copper. The EPA Office of Drinking Water maximum contaminant level (MCL) of 1.3 mg/L has been converted to a surrogate oral RfD estimate of 3.7×10^{-2} mg/kg-day by assuming ingestion of 2 L water/day for a 70 kg adult (U.S. EPA 1994b).

Lead. Currently, EPA does not provide toxicity data for lead because of unique considerations related to the toxicology of this element. As an alternative to the traditional risk assessment approach, EPA recommends modeling blood lead levels and comparing them with acceptable blood lead concentrations for residential exposure scenarios (U.S. EPA 1994a, 1994c).

Petroleum Hydrocarbons. Approved toxicity values for petroleum hydrocarbons are not available. These fuels are complex hydrocarbon mixtures produced by distillation of crude oil. They may contain hundreds of hydrocarbon components, as well as additives.

The actual composition of any given fuel may vary depending on the source of crude oil, refinery processes used, and product specifications. Risk due to exposure of TPH was evaluated by calculating risks for the most toxic constituents (benzene, ethylbenzene, toluene, xylenes).

7.1.3 Exposure Assessment

The objective of the exposure assessment is to estimate the types and magnitude of human exposure to COPCs at OU A. This exposure assessment is based on and is consistent with the EPA's risk assessment guidance (U.S. EPA 1989, 1991a, 1991b). Exposure media, potentially exposed current and future populations, and exposure pathways were evaluated. A summary of exposure pathways evaluated in the RI appears in Table 7-1. Risk to subsistence fishers and subsistence shellfish harvesters was not fully evaluated as part of Operable Unit A. Risk to subsistence fishers and subsistence shellfish harvesters will be fully evaluated as part of Operable Unit B.

In order to calculate human intake of chemicals, exposure point concentrations must be estimated. Exposure point concentrations are those concentrations of each chemical to which an individual may potentially be exposed for each medium at the site. Exposure point concentrations were developed from analytical data obtained during the investigation.

Exposure point concentrations were calculated for both an average exposure and a reasonable maximum exposure (RME) for surface soils at depths ranging from 0.5 to 2.0 feet and for subsurface soils at depths ranging from 0.5 to 15 feet.

The RME corresponds to the highest exposure that may be reasonably anticipated for a site. The RME concentration is designed to be higher than the concentration that will be experienced by most individuals in an exposed population. The RME concentration was calculated as the lesser of the maximum detected concentration or the 95 percent confidence limit on the arithmetic mean.

The average exposure scenario was evaluated to allow comparison with the RME. The average scenario is intended to be more representative of likely human exposure at the site. Each average exposure point concentration was calculated as an arithmetic average of the chemical results for a particular medium using half the sample quantitation limit (SQL) for nondetected chemicals (see Tables 7-2 through 7-7).

Estimates of potential human intake of chemicals for each exposure pathway were calculated by combining exposure point concentrations with pathway-specific exposure assumptions (for parameters such as ingestion rate, body weight, exposure frequency, and exposure duration) for each medium of concern. Exposure parameters used in the risk assessment calculations were based on a combination of EPA Region 10 default values (U.S. EPA 1991a) and site-specific exposure assumptions. One of the site-specific exposure assumptions used in the OU A risk assessment was the consumption rate of shellfish. Native Americans are the most at-risk population because of subsistence use of shellfish. As suggested by Ecology, a site-specific exposure assumption was developed that assumes a person would eat 8.8 grams of shellfish per day, 365 days per year for 30 years. A more conservative subsistence scenario meant to reflect Native American dietary habits was also evaluated by EPA. Exposure parameters used in the risk assessment are presented in Tables 7-8 through 7-11.

7.1.4 Risk Characterization

A risk characterization was performed to estimate the likelihood that adverse health effects would occur in exposed populations. The risk characterization combines the information developed in the exposure assessment and toxicity assessment to calculate risks for cancer and noncancer health effects. Because of fundamental differences in the mechanisms through which carcinogens and noncarcinogens act, risks were characterized separately for cancer and noncancer effects.

Noncancer Effects

The potential for adverse noncancer effects from a single contaminant in a single medium is expressed as a hazard quotient (HQ). An HQ is calculated by dividing the average daily chemical intake derived from the contaminant concentration in the particular medium by the RfD for the contaminant. The RfD is a dose below which no adverse health effects are expected to occur.

By adding the HQs for all contaminants within a medium and across all media to which a given population may reasonably be exposed, an HI can be calculated. The HI represents the combined effects of all the potential exposures that may occur for the scenario being evaluated. If the HI is less than or equal to 1, noncancer health effects are unlikely. If the HI for a common endpoint is greater than 1, it indicates that adverse health effects are possible.

Table 7-8
Summary of Pathway-Specific Exposure Parameters for OU A: Current Utility Worker and Transit-Walker

Exposure Pathway	Parameter	Units	Utility Worker		Transit-Walker	
			RME	Average	RME	Average
Ingestion of chemicals in soil	Ingestion rate	mg/day	15	15	NA	NA
	Exposure frequency	days/yr	9	6	NA	NA
	Exposure duration	yrs	25	10	NA	NA
	Body weight	kg	70	70	NA	NA
	Averaging time	days	9,125 (noncancer) 25,550 (cancer)	3,650 (noncancer) 25,550 (cancer)	NA	NA
	Conversion factor	kg/mg	1×10^{-6}	1×10^{-6}	NA	NA
	Summary intake factor	kg soil/ kg-day	5.3×10^{-9} (noncancer) 1.9×10^{-9} (cancer)	3.5×10^{-9} (noncancer) 5.0×10^{-10} (cancer)	NA	NA
Inhalation of airborne particulates	Particulate emission factor	m^3/kg	4.63×10^9	4.63×10^9	4.63×10^9	4.63×10^9
	Inhalation rate	m^3/hr	4.8	2.5	0.6	0.6
	Exposure time	hrs/day	2.4	2.4	0.014	0.014
	Exposure frequency	days/yr	9	6	250	250
	Exposure duration	yrs	25	10	25	10
	Body weight	kg	70	70	70	70
	Averaging time	days	9,125 (noncancer) 25,550 (cancer)	3,650 (noncancer) 25,550 (cancer)	9,125 (noncancer) 25,550 (cancer)	3,650 (noncancer) 25,550 (cancer)
	Summary intake factor	kg soil/ kg-day	8.8×10^{-13} (noncancer) 3.1×10^{-13} (cancer)	3.0×10^{-13} (noncancer) 4.3×10^{-14} (cancer)	1.8×10^{-14} (noncancer) 2.5×10^{-15} (cancer)	1.8×10^{-14} (noncancer) 6.3×10^{-15} (cancer)

Table 7-8 (Continued)
Summary of Pathway-Specific Exposure Parameters for OU A: Current Utility Worker and Transit-Walker

Exposure Pathway	Parameter	Units	Utility Worker		Transit-Walker	
			RME	Average	RME	Average
Dermal contact with chemicals in soil	Skin surface area	cm^2/event	1,900	1,900	NA	NA
	Soil-to-skin adherence factor	mg/cm^2	1.0	0.6	NA	NA
	Absorption factor	unitless	Chemical-specific		NA	NA
	Exposure frequency	events/yr	9	6	NA	NA
	Exposure duration	yrs	25	10	NA	NA
	Body weight	kg	70	70	NA	NA
	Averaging time	days	9,125 (noncancer) 25,550 (cancer)	3,650 (noncancer) 25,550 (cancer)	NA	NA
	Conversion factor	kg/mg	1×10^{-6}	1×10^{-6}	NA	NA
	Summary intake factor	kg soil/ kg-day	6.7×10^{-7} (noncancer) 2.4×10^{-7} (cancer)	4.0×10^{-7} (noncancer) 5.7×10^{-8} (cancer)	NA	NA

Notes:
Exposure parameters other than those recommended by the EPA are discussed in the text.
NA Not applicable
RME Reasonable maximum exposure

Table 7-9
Exposure Parameters for the Future Resident

Exposure Route	Parameter	Units	RME		Average
			Adult	Child	Adult
Ingestion of chemicals in soil	Ingestion rate	mg/day	100	200	100
	Exposure frequency	days/yr	350	350	275
	Exposure duration	yrs	24	6	9
	Body weight	kg	70	15	70
	Averaging time				
	Noncancer	days	8,760	2,190	3,285
	Cancer	days	25,550	25,550	25,550
	Conversion factor	kg/mg	1×10^{-6}	1×10^{-6}	1×10^{-6}
	Summary intake factor				
	Noncancer	kg soil/kg-day	3.7×10^{-6}	1.3×10^{-5}	1.1×10^{-6}
	Cancer	kg soil/kg-day	1.6×10^{-6}	1.1×10^{-6}	1.4×10^{-7}
Dermal contact with chemicals in soil	Surface area	cm^2/event	2,675	3,900	2,675
	Adherence factor	mg/cm^2	1.0	1.0	1.0
	Exposure frequency	days/yr	350	350	275
	Exposure duration	yrs	24	6	9
	Averaging time				
	Noncancer	days	8,760	2,190	3,285
	Cancer	days	25,550	25,550	25,550
	Conversion factor	kg/mg	1×10^{-6}	1×10^{-6}	1×10^{-6}
	Summary intake factor				
	Noncancer	kg soil/kg-day	7.9×10^{-5}	2.5×10^{-4}	1.7×10^{-5}
	Cancer	kg soil/kg-day	3.4×10^{-5}	2.1×10^{-5}	2.2×10^{-6}
Inhalation of chemicals absorbed to particulates	Inhalation rate	m^3/day	20	NA	20
	Exposure frequency	days/yr	350	NA	275
	Exposure duration	yrs	30	NA	9
	Body weight	kg	70	NA	70

Table 7-9 (Continued)
Exposure Parameters for the Future Resident

Exposure Route	Parameter	Units	RME		Average
			Adult	Child	Adult
Inhalation of chemicals adsorbed to particulates	Averaging time				
	Noncancer	days	10,950	3,285	3,285
	Cancer	days	25,550	25,550	25,550
	Summary intake factor				
	Noncancer	m^3 air/kg-day	2.7×10^{-1}		2.2×10^{-1}
	Cancer	m^3 air/kg-day	1.2×10^{-1}		2.8×10^{-2}

Notes:
Exposure parameters other than those recommended by EPA are discussed in the text.
NA Not applicable
RME Reasonable maximum exposure

Table 7-10
Exposure Parameters for the Future Industrial Worker

Exposure Route	Parameter	Units	RME Adult	Average Adult
Ingestion of chemicals in soil	Ingestion rate	mg/day	50	50
	Exposure frequency	days/yr	250	250
	Exposure duration	yrs	25	10
	Body weight	kg	70	70
	Averaging time			
	Noncancer	days	9,125	3,650
	Cancer	days	25,550	25,550
	Conversion factor	kg/mg	1×10^{-6}	1×10^{-6}
	Summary intake factor			
	Noncancer	kg soil/kg-day	4.9×10^{-7}	4.9×10^{-5}
	Cancer	kg soil/kg-day	1.8×10^{-7}	7.0×10^{-8}
Dermal contact with chemicals in soil	Surface area	cm^2/event	1,900	1,900
	Adherence factor	mg/cm^2	1.0	1.0
	Exposure frequency	days/yr	250	250
	Exposure duration	yrs	25	10
	Averaging time			
	Noncancer	days	9,125	3,650
	Cancer	days	25,550	25,550
	Conversion factor	kg/mg	1×10^{-6}	1×10^{-6}
	Summary intake factor			
	Noncancer	kg soil/kg-day	1.9×10^{-5}	1.9×10^{-5}
	Cancer	kg soil/kg-day	6.6×10^{-5}	2.7×10^{-6}
Inhalation of chemicals absorbed to particulates	Inhalation rate	m^3/day	20	20
	Exposure frequency	days/yr	250	250
	Exposure duration	yrs	25	10
	Body weight	kg	70	70
Inhalation of chemicals adsorbed to particulates	Averaging time			
	Noncancer	days	9,125	3,650
	Cancer	days	25,550	25,550
	Summary intake factor			
	Noncancer	m^3 air/kg-day	2.0×10^{-1}	2.0×10^{-1}
	Cancer	m^3 air/kg-day	7.0×10^{-2}	2.8×10^{-2}

Notes:
Exposure parameters other than those recommended by the EPA are discussed in the text.
NA Not applicable
RME Reasonable maximum exposure

Table 7-11
Summary of Exposure Parameters for the Shellfish Harvester and Fisher

Exposure Route	Parameter	Units	Shellfish Harvester	Fisher
Ingestion of chemicals in fish and shellfish	Ingestion rate	g/day	8.8	26.1
	Fraction ingested	unitless percent	50	50
	Exposure frequency	days/yr	365	365
	Exposure duration	yrs	30	30
	Body weight	kg	70	70
	Averaging time	days	10,950[a] 25,550[b]	10,950[a] 25,550[b]
	Conversion factor	kg/g	1×10^{-3}	1×10^{-3}
	Summary intake factor	kg fish/kg-day	6.3×10^{-5} [a] 2.7×10^{-5} [b]	1.7×10^{-4} [a] 8×10^{-5} [b]
Dermal contact with chemicals in sediment	Soil to skin adherence factor	mg/cm^2	0.1	NA
	Skin surface area	cm^2/day	1,900	NA
	Absorption factor	—Chemical Specific—		
	Exposure frequency	days/yr	6	NA
	Exposure duration	yrs	30	NA
	Body weight	kg	70	NA
	Averaging time	days	10,950[a] 25,550[b]	NA
	Conversion factor	kg/mg	1×10^{-6}	NA
	Summary intake factor	kg sediment/kg-day	3.9×10^{-6} [a] 1.7×10^{-6} [b]	NA
Ingestion of chemicals in sediments	Ingestion rate	mg/day	100	NA
	Exposure frequency	days/yr	6	NA
	Exposure duration	yrs	30	NA
	Body weight	kg	70	NA
	Averaging time	days	10,950[a] 25,550[b]	NA
	Conversion factor	kg/mg	1×10^{-6}	NA

Table 7-11 (Continued)
Summary of Exposure Parameters for the Shellfish Harvester and Fisher

Exposure Route	Parameter	Units	Shellfish Harvester	Fisher
Ingestion of chemicals in sediments (cont.)	Summary intake factor	kg sediment/kg-day	2.0×10^{-7} [a] 8.7×10^{-8} [b]	NA

[a]Noncancer
[b]Cancer

Notes:
Exposure parameters other than those recommended by the EPA are presented in the text.
NA Not applicable

Cancer Risks

The potential health risks associated with carcinogens are estimated by calculating the increased probability of an individual's developing cancer during his or her lifetime as a result of exposure to a carcinogenic substance. Excess lifetime cancer risks are calculated by multiplying the cancer SF by the daily chemical intake averaged over a lifetime of 70 years.

A cancer risk estimate is a probability that is expressed as a fraction less than 1. For example, an excess lifetime cancer risk of 0.000001 (or 10^{-6}) indicates that, as a plausible upper bound estimate, an individual has a one-in-one-million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at the site. An excess lifetime cancer risk of 0.0001 (or 10^{-4}) represents a one-in-ten-thousand chance. The EPA recommends (in the NCP) an acceptable target risk range for excess cancer risk of 0.000001 to 0.0001 (or 10^{-6} to 10^{-4}) at CERCLA sites.

Results

Table 7-12 summarizes the risk characterization results for each exposure scenario evaluated for OU A.

Except for future residential and future industrial exposures at the RME level, the human health risks were all below the EPA's target levels (HI less than 1, excess lifetime cancer risk less than 10^{-4}). Risks above 10^{-4} were predicted only for the future residential and future industrial scenarios and were associated with heavy metals (arsenic), PCBs, PAHs, and BEHP at elevated levels in soils.

An unacceptable noncancer risk (HI greater than 1) results from the exposure of future residents to contaminated soils. The chemical causing most of the risks is arsenic. This chemical was found in soils from the fill area.

Lead soil concentrations, detected at 0 to 8 feet in depth, exceeded the EPA soil screening level of 400 mg/kg and the MTCA A industrial cleanup level of 1,000 mg/kg. A hypothetical child resident, who might ingest lead-contaminated soil, was evaluated using the EPA Lead Integrated Exposure Uptake Biokinetic model (U.S. EPA 1994) and EPA's default exposure assumptions. The predicted model blood lead levels calculated

Table 7-12
Summary of Potential Human Health Risks at OU A

Exposure Scenario	Cumulative Risk	Chemicals Contributing to Risk in Specific Media		
		Soil	Sediment	Fish/Shellfish
Current Transit Walker Scenario				
RME	HI = 5.4×10^{-6}	NR (Pb[b])	NP	NP
	CR < 1×10^{-6}	NR	NP	NP
Current Utility Worker Scenario				
RME	HI < 1	NR (Pb)[b]	NP	NP
	CR = 2×10^{-6}	As	NP	NP
Future Resident Scenario				
RME	HI = 5.4	As, Pb[b]	NP	NP
	CR = 8×10^{-4}	As, PCBs, PAHs, BEHP	NP	NP
Future Industrial Worker				
RME	HI = 1.2	As, PCBs	NP	NP
	CR = 1×10^{-4}	As, Be, PCBs, PAHs	NP	NP
Future Shellfish Harvester				
RME	HI = 0.01	NP	NR	NR
	CR = 8.9×10^{-6}	NP	As	Aroclor 1254
Future Fisher				
RME	HI = 0.1	NP	NP	NR
	CR = 9×10^{-5}	NP	NP	Aroclor 1260, aldrin

[a]Each of the chemicals listed for a particular medium poses a cancer risk greater than 10^{-6} or contributes significantly (>30%) to the hazard quotient due to exposure pathways for that medium. No chemicals are listed for any medium for those exposure scenarios having a cumulative cancer risk less than 10^{-6} or a noncancer hazard index less than 1.

[b]Health risks were not calculated for lead. However, lead concentrations exceeded the EPA soil screening level of 400 mg/kg and the MTCA A industrial cleanup level of 1,000 mg/kg.

Table 7-12 (Continued)
Summary of Potential Human Health Risks at OU A

CHEMICAL ABBREVIATIONS

As	Arsenic
Be	Beryllium
BEHP	Bis(2-ethylhexyl)phthalate
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls (Aroclors)

OTHER ABBREVIATIONS

CR	Cancer risk
HI	Hazard index
NP	This pathway was not included in the human exposure model
NR	No risk-contributing chemicals are listed for this medium (see footnote [a])
RME	Reasonable maximum exposure

with OU A soil concentrations were found to exceed the recommended level of 10 μg lead/deciliter of blood in a child.

Uncertainty

Many uncertainties are inherent in the human health risk assessment process. Uncertainty is introduced during each step of a risk assessment. For example, very high SQLs may mask the detection of chemicals present at the site and may result in an underestimation of risks. The percent of SQLs exceeding risk-based value was less than 10 percent indicating a minimal risk of underestimating site risks. Using toxicity values that have a high degree of uncertainty may result in an overestimation of risks. Calculated future risks are highly uncertain to the extent that future land use assumptions are hypothetical (e.g., exposure may never occur), and the magnitude of future exposure concentrations is unknown and may overestimate risks. At OU A, 10 chemicals lacked toxicity values. Exclusion of these chemicals from the risk assessment could result in an underestimation of site risks.

7.2 ECOLOGICAL RISK ASSESSMENT

A quantitative ecological risk assessment was performed for marine (sediment and shellfish tissue) habitats at OU A. The format for the ecological risk assessment followed the EPA ecological risk assessment framework (U.S. EPA 1992b). Hence, risk characterization defines the likelihood of adverse effects occurring as a result of exposure to site contaminants.

Separate baseline ecological risk assessments were conducted for the terrestrial, intertidal, and subtidal habitats at OU A. The terrestrial habitat at OU A is highly disturbed and provides little vegetative cover. Because the quality and extent of the terrestrial habitat at OU A is limited, it cannot sustain a viable wildlife population. Therefore, an ecological risk assessment of the terrestrial portion of OU A was not warranted.

A small, intertidal sandy beach habitat exists on OU A. Maintenance of the habitat for shorebirds was identified as the assessment endpoint for the ecological risk assessment. Food chain modeling with the spotted sandpiper as the target species was used as the measurement endpoint. Results of the risk assessment suggest that shorebirds may be at risk from arsenic, cadmium, and mercury in the sediment and in the benthic macroinvertebrates that they ingest.

The marine habitat of OU A consists predominantly of subtidal habitat. Four assessment endpoints were identified for evaluating ecological risks to the subtidal habitat:

- Maintenance of benthic invertebrate diversity and abundance
- Maintenance of viable mussel and clam populations
- Maintenance of viable bottom-dwelling fish populations
- Maintenance of the habitat for birds that feed on marine biota

The maintenance of benthic invertebrate diversity and abundance was evaluated using two measurement endpoints: (1) comparison of sediment chemistry data to SQVs that represent sediment chemical concentrations below which adverse impacts are unlikely and (2) sediment bioassays. Results of the sediment chemistry comparisons show that chlordane, copper, DDT and its metabolites, lead, mercury, nickel, PCBs, and zinc present high-priority risks, whereas antimony, arsenic, cadmium, PAHs, and phthalate esters present medium-priority risks. Bioassays using three test organisms at two OU A sampling stations showed no adverse effects.

The maintenance of viable mussel and clam populations was assessed by comparing tissue analytical results from a caged mussel study with maximum acceptable tissue concentrations. The caged mussel study was performed as part of the RI for adjoining OU B. Results suggest that chromium, lead, nickel, selenium, and zinc pose risks to shellfish populations.

The maintenance of viable bottom-dwelling fish populations was assessed by comparing tissue analytical results for mussels with maximum acceptable tissue concentrations (based on ecological risk-based screening concentrations presented as effect range-low [ER-L], a concentration in sediments below which adverse effects are considered unlikely [Long et al. 1995]). Results suggest that antimony, copper, di-n-butylphthalate, endosulfan II, lead, nickel, and zinc pose risks to bottom-dwelling fish populations.

The maintenance of shoreline habitat and the viability of birds feeding on marine biota were assessed using food chain modeling. The surf scoter was used to assess risks to a shellfish-eating bird and the pigeon guillemot was used to assess risks to a fish-eating bird. Results suggest that shellfish-eating birds may be at risk from mercury in the shellfish and sediment that they consume, and fish-eating birds may be at risk from endrin ketone, lead, and mercury in the fish and sediment that they consume.

Copper, lead, mercury, nickel, zinc, and PCBs were identified as chemicals of concern in 50 percent or more of the ecological risk scenarios (Table 7-13). These five chemicals are believed to be the major overall risk drivers for Sinclair Inlet biota because they exceeded several different measurement endpoints (comparison to the SMS, tissue residues, and food chain modeling). Table 7-14 presents the ecological risk drivers.

Uncertainty

There are many factors contributing to the uncertainty of the ecological risk assessment. At OU A, toxicity reference values may overestimate the risks of inorganic chemicals because the toxicity values were derived from laboratory toxicity tests that used soluble and therefore toxic forms of the chemicals. Ingestion rates may not represent site- or species-specific conditions because they were obtained from a limited literature database. Extrapolating concentrations of chemicals derived for one species to a second species introduces an unknown quantity into the risk uncertainty and may overestimate the risk.

7.3 RISK ASSESSMENT

The results of the human health risk assessment indicate carcinogenic and noncarcinogenic risks associated with future residential and future industrial scenarios. Carcinogenic risk drivers in the reasonable maximum exposure scenario were identified as arsenic, beryllium (for future workers only), PCBs, and PAH compounds. Noncarcinogenic risks were primarily associated with arsenic, which was the only chemical that had a hazard quotient greater than 1.0 and which accounted for 61 percent of the noncarinogenic hazard index for the site. Antimony, copper, mercury, and PCBs were the only other chemicals that had a hazard quotient greater than 0.1 (Figure 7-1). Although no toxicity values are available for lead, concentrations of lead did exceed both EPA screening levels for residential exposure and Ecology screening levels for industrial exposure. Therefore, lead is also considered a chemical of concern.

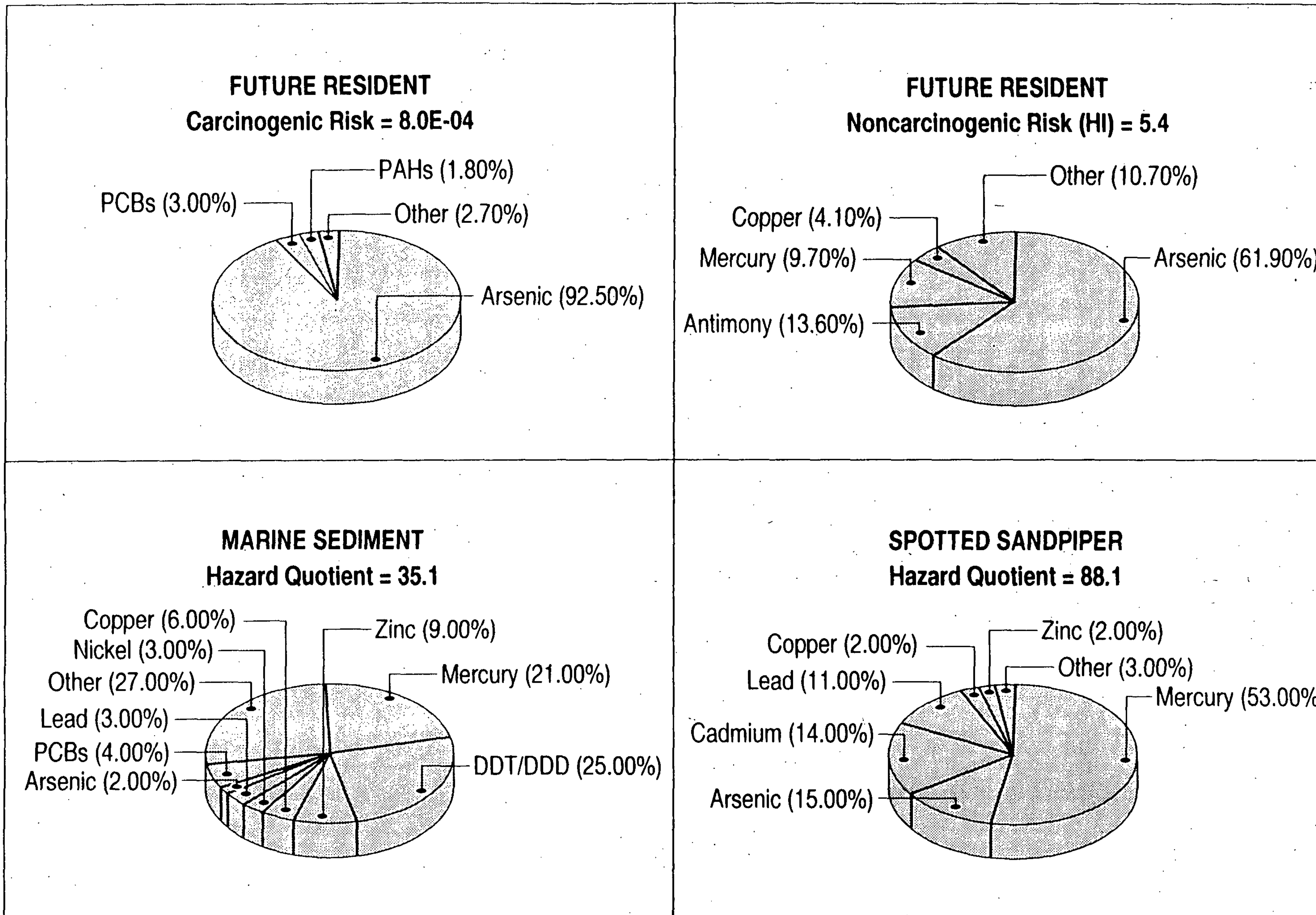
Table 7-13
Chemicals of Concern for Each Exposure Scenario Studied at OU A

Human health—transit-walker	• Lead
Human health—utility worker	• Lead • Arsenic
Human health—future resident and future industrial worker	• Arsenic • Beryllium (future industrial only) • Lead • PCBs
Human health—shellfish harvester	• PCBs
Human health—fisherman	• PCBs, Aldrin
Sediment—high priority	• Copper • Lead • Mercury • Nickel • Zinc • Chlordane • DDT and metabolites • PCB
Sediment—medium priority	• Antimony • Arsenic • Cadmium • PAH • Phthalate esters
Blue mussel	• Chromium • Lead • Mercury • Nickel • Selenium • Zinc • PCBs
English sole	• Antimony • Copper • Lead • Nickel • Zinc • Endosulfan II • PCBs
Pigeon guillemot	• Lead • Mercury • Endrin ketone
Surf scoter	• Mercury
Spotted sandpiper	• Arsenic • Cadmium • Copper • Lead • Mercury • Zinc

Table 7-14
Summary of Potential Ecological Health Risks at OU A

Species	RME Hazard Index	Risk Drivers
Sediment	35.1	Mercury, DDT, zinc, DDD, copper, phenol
Spotted sandpiper	88.1	Arsenic, cadmium, lead, mercury
Blue mussels	22	Chromium, lead, nickel, selenium, zinc
English sole	33	Antimony, copper, lead, zinc
Pigeon guillemot	10.8	Lead, mercury, endrin ketone
Surf scoter	6.1	Mercury

Notes:
RME Reasonable Maximum Exposure



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 7-1** **Risk Drivers**	CTO 0160 PSNS OU A Bremerton, Washington FINAL ROD

533160006-201-112096

Ecological risk was identified for:

- Shellfish populations from chromium, lead, nickel, selenium, and zinc
- Bottom-dwelling fish populations from antimony, copper, lead, nickel, zinc, and endosulfan II
- Fish and shellfish-eating birds from endrin ketone, lead, and mercury
- Shorebirds from arsenic, cadmium, lead, mercury, copper, and zinc

8.0 REMEDIAL ACTION OBJECTIVES

8.1 NEED FOR REMEDIAL ACTION

Remedial action objectives (RAOs) consist of medium-specific or operable unit-specific goals for protecting human health and the environment. The objectives should be as specific as possible, but not so specific that the range of alternatives that can be developed is unduly limited. RAOs were developed for OU A for those chemicals of concern identified by comparing laboratory results to chemical-specific regulations and as a result of the baseline risk assessment. The regulations addressed in the FS report include MTCA screening levels that focus on water quality standards and on human exposure via direct contact or via ingestion of soil, groundwater, or marine life.

Land use at OU A is expected to remain industrial in the future based on the important role of the Bremerton Naval Complex. The RAOs were developed on this basis.

The general conclusion of the baseline risk assessment is that the predicted cancer and noncancer risks posed by chemicals at OU A are slightly above or within established acceptable ranges for soils and above acceptable ranges with respect to fish and shellfish that are consumed by hypothetical subsistence consumers. However, lead concentrations observed in soil, but not included in the calculated risks, present a health risk to site workers and hypothetical future residents.

8.2 RAOs

The primary RAOs for OU A include:

- Prevent people from coming in contact with soil containing lead, arsenic, PCBs, and PAHs above acceptable levels
- Reduce the physical hazards associated with the existing riprap, such as exposed scrap metal, construction debris, and fill materials
- Limit erosion of heavy metal and organic constituents in fill materials to Sinclair Inlet marine waters through the existing riprap

- Reduce the transport of chemicals to groundwater or the marine environment

- Enhance terrestrial and marine habitat

The rationale for each of the RAOs are described in this section.

8.2.1 Soils

The RAO for soil is to prevent human exposure to the chemicals of concern. The soil exposure pathways to be controlled are direct contact with soil and ingestion of soil. Based on the results of the risk assessment and comparison to MTCA C Industrial standards, the chemicals in soils at OU A for which remedial actions are required are cPAHs, PCBs, arsenic, and lead. Inorganics are likely associated with industrial wastes disposed of in the fill materials. PCBs and PAHs may have been present in the fill material used to develop the site; the latter could also be associated with petroleum contamination. Levels of contamination are substantially higher in Zone II than in Zones I and III. Limited portions of the riprap along the northern parts of Zone II also exhibit evidence of fill materials. These materials may represent a direct source of contaminants to Sinclair Inlet. The remediation goals for these chemicals are shown in Table 8-1.

8.2.2 Groundwater

Groundwater Evaluation as Drinking Water

Groundwater throughout OU A fails to meet state and federal standards for drinking water. However, the drinking water standards are not appropriate cleanup standards because it is not reasonable to evaluate this groundwater as though it were potable. It is currently not used as a drinking water source and is a very unlikely future source of drinking water.

To assess the potability of groundwater at OU A, the general requirements defined by WAC 173-340-720(1)(a)(i), (ii), and (iii) have been applied:

(i) The groundwater does not serve as a current source of drinking water.

(ii) The groundwater is not a potential future source of drinking water for any of the following reasons:

(a) Contains natural background concentrations of inorganic constituents (e.g., potassium and sodium) that make using the water for drinking not practicable. Groundwater containing total dissolved solids at concentrations greater than 10,000 mg/L will normally be considered to have fulfilled this requirement.

(b) The groundwater is situated at a great depth or a location that makes recovery of water for drinking water purposes technically impossible.

(iii) Potential indicator chemicals in groundwater will not be transported to groundwater that is a current or potential future source of drinking water.

No on-site groundwater is used for drinking water. All drinking water is imported via pipeline from the city of Bremerton. Therefore, the first requirement has been met, because groundwater does not serve as a current source of drinking water.

The salinity profile for the site (URS 1995a) shows that groundwater is tidally influenced. Five monitoring wells in Zone II and two wells in Zone I have total dissolved solids (TDS) concentrations greater than 10,000 mg/L and therefore meet the second requirement; that is, they are not suitable sources of drinking water. In addition, if groundwater was extracted from the aquifer at OU A, saltwater intrusion from Sinclair Inlet would increase, thereby further increasing TDS levels in the aquifer.

OU A and adjoining State Highway 304 and the commercial facilities upgradient of the site are located near the base of a bluff. The net downgradient flow of groundwater at OU A toward Sinclair Inlet precludes the transport of chemicals upgradient to a properly located drinking water well. Therefore, the third requirement for excluding the groundwater from drinking water standards has been met.

In addition, under WAC 173-160-205(2), individual domestic wells may not be located within 100 feet of known or suspected areas of contamination. As shown by the test results from MW208, groundwater contaminated with benzene exists upgradient of OU A. The upper parking lot in Zone III is less than 100 feet downgradient of a suspected source of contamination that is located off site and across State Highway 304.

Based on this evaluation, the concern that groundwater could be consumed by future residents at OU A has been eliminated. The probability that groundwater at OU A will be used as a source of drinking water in the future is negligible.

Groundwater Evaluation as a Source of Chemical Transport to Sinclair Inlet

The movement of groundwater from OU A to Sinclair Inlet transports dissolved chemicals to the marine environment. Thus, it is possible that the OU A contaminants could contribute to adverse effects in marine life in the inlet. Evaluations of fate and transport processes involving this pathway were performed during development of the FS and proposed plan. These evaluations indicated that under current site conditions, the mass flux of contaminants in OU A groundwater into the marine water does not significantly affect ambient concentrations in Sinclair Inlet.

Multiple linear regression analyses were conducted for contaminant levels in site media (soil, groundwater, and marine sediments). The resulting regression equations indicate how concentrations of inorganic and organic chemicals in groundwater, for example, vary with those found in soil. Figure 8-1 shows that although chemical levels in subtidal (and likely intertidal) marine sediments are highly correlated to those in the terrestrial fill, neither sediment nor soil chemical levels are correlated with those found in low-flow sampling results for groundwater at the detection limits achieved during the RI sampling. The implication is that marine sediments likely were affected by waste disposal practices in the past, but that ***currently*** those chemicals are not being transported at appreciable levels to Sinclair Inlet by groundwater flow from terrestrial areas of the site.

The potential risks from groundwater will be further studied for the entire Bremerton Naval Complex as part of the RI/FS for OU B, including an ecological risk assessment for the marine environment of Sinclair Inlet. If the OU B study establishes that OU A contaminated groundwater to OU B ecological receptors represents an unacceptable impact, additional consideration may have to be given to active remedial action measures for OU A groundwater.

Concentrations of dissolved inorganics detected in monitoring wells and a nearshore seep exceeded state or federal chronic marine water standards for arsenic, copper, lead, nickel, silver, thallium, zinc, pesticides, PAHs, and PCBs. Elevated levels of arsenic, copper, lead, nickel, and zinc were also found in marine sediments.

	X: Subtidal Sediment	X: Total Groundwater	X: Dissolved Groundwater	X: Soil
Y: Subtidal Sediment		**111.32+192.08X** *0.02*	**213.45+197.48X** *0.01*	**2.10+.48X** *0.97*
Y: Total Groundwater			**-0.02+1.23X** *0.96*	**0.05+5.20E-05X** *0.02*
Y: Dissolved Groundwater				**0.10+3.66E-05X** *0.02*
Y: Soil				

KEY

Multiple linear regression model coefficients relating dependent variable concentration (**Y**) in ppm to independent variable concentration (**X**) in ppm.

R^2 Value

Sample size = 23 analytes

Diagonal hatching: >90% correlation between dependent and independent variable

Grey shading: <50% correlation between dependent and independent variable

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Figure 8-1
Cross-Media Correlations

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Chemicals that frequently exceeded surface water standards in groundwater and have been identified as discharging to Sinclair Inlet at levels exceeding surface water standards in seeps should be monitored to ensure that the conclusion that the site presents low risk continues to be justified. Also, groundwater impacts should be considered where remedies are selected for other media. Therefore, the RAO established for groundwater is to reduce the potential for arsenic, copper, nickel, lead, zinc, PAHs, pesticides, and PCBs to reach the groundwater, to the extent feasible using technologies that are implementable and effective for the site. Under MTCA, groundwater cleanup levels can be set at concentrations based on the protection of beneficial uses of surface water. The remediation goals for these chemicals are shown in Table 8-1.

8.2.3 Surface Water

Surface water at the site flows through storm drains that are monitored by the Navy and maintained under the NPDES program. No specific RAOs were developed for surface water.

8.2.4 Marine Sediments

The need for remedial action of marine sediments and biota will be addressed in the ROD for OU B. Consequently, no RAOs or cleanup levels were developed for this ROD.

8.2.5 Total Petroleum Hydrocarbons

The need for remedial action of petroleum hydrocarbons in soils and groundwater will be addressed by a facility-wide petroleum hydrocarbon cleanup program. Consequently, no RAOs or cleanup levels were developed for this ROD.

8.3 REMEDIATION GOALS

Remediation goals for soil and groundwater are presented in Table 8-1. The goals for soil are based on MTCA C Industrial levels since this site will remain in industrial use indefinitely. The goals for groundwater are based on the most stringent of federal and state surface water quality criteria. These include ambient water quality criteria for human health based on fish and shellfish ingestion (MTCA B, NTR) and on the protection of biota (federal AWQ, State AWQ, and NTR). These will be adjusted by

Table 8-1
(Proposed) Soil and Groundwater Cleanup Levels for OU A

Parameter	CAS No.	Regulatory Level	Basis	Practical Quantitation Limit	Ambient Value[a]	Cleanup Level[b]
Soil						
Arsenic	7440-38-2	219	MTCA C Industrial	5	NA	219
Lead	7439-92-1	1,000	MTCA A Industrial	5	NA	1,000
Individual cPAHs	56-55-3, 50-32-8, 205-99-2, 207-08-9, 218-01-9, 53-70-3, and 193-39-5	18	MTCA C Industrial	1	NA	18
Total PCBs	1336-36-3	17	MTCA C Industrial	0.1	NA	17
Groundwater						
Arsenic	7440-38-2	0.0982	MTCA B	0.5	10	0.5
Copper	7440-50-8	2.5	State WQC	2.5	93.5	2.5
Lead	7439-92-1	5.8	State WQC	5	12.3	5.8
Nickel	7440-02-0	7.9	State WQC	5	10.4	7.9
Zinc	7440-66-6	76.6	State WQC	5	136	76.6
Benzo(a)anthracene	56-55-3	0.0296	MTCA B	5	NA	5
Benzo(a)pyrene	50-32-8	0.0296	MTCA B	5	NA	5
Benzo(b)fluoranthene	205-99-2	0.0296	MTCA B	5	NA	5
Benzo(k)fluoranthene	207-08-9	0.0296	MTCA B	5	NA	5
Chrysene	218-1-9	0.0296	MTCA B	5	NA	5
Indeno(1,2,3-cd)pyrene	193-39-5	0.0296	MTCA B	5	NA	5
BEHP	117-81-7	3.56	MTCA B	5	NA	5
Aldrin	309-00-2	0.0000816	MTCA B	0.01	NA	0.01
Dieldrin	60-57-1	0.0000867	MTCA B	0.02	NA	0.02

Table 8-1 (Continued)
(Proposed) Soil and Groundwater Cleanup Levels for OU A

Parameter	CAS No.	Regulatory Level	Basis	Practical Quantitation Limit	Ambient Value[a]	Cleanup Level[b]
Endrin	72-20-8	0.0023	State WQC	0.02	NA	0.02
alpha-Chlordane	57-74-9	0.000354	MTCA B	0.01	NA	0.01
gamma-Chlordane	57-74-9	0.000354	MTCA B	0.01	NA	0.01
4,4'-DDD	72-54-8	0.000504	MTCA B	0.02	NA	0.02
4,4'-DDE	72-55-9	0.000356	MTCA B	0.02	NA	0.02
4,4'-DDT	50-29-3	0.000356	MTCA B	0.02	NA	0.02
Aroclor 1260	1336-36-3	0.000027	MTCA B	0.02	NA	0.02

[a]Background value for upgradient wells at the current time.
[b]Cleanup level established as the higher of the regulatory level or the practical quantitation limit (see WAC 173-340-700[6] and Washington State Department of Ecology Implementation Memo No. 3 [dated November 24, 1993]).

Notes:
Soil and groundwater cleanup levels are based on industrial site usage for current workers, as well as the protection of adjacent surface waters of Sinclair Inlet. Soil cleanup levels based on the latter will be defined, if appropriate, in the Record of Decision for Operable Unit B.

Values for soils are in mg/kg. Values for groundwater are in μg/L.
— - No CAS number available
CAS - Chemical Abstract Service Registry Number
cPAH - carcinogenic polycyclic aromatic hydrocarbon
MTCA - Model Toxics Control Act
NA - not applicable
PCB - polychlorinated biphenyl
WQC - water quality criteria

consideration of practical quantitation limits and ambient groundwater concentrations. The ambient groundwater concentrations are included for comparison.

9.0 DESCRIPTION OF ALTERNATIVES

It is the intent of the Navy, Ecology, and the EPA to reduce the risk to humans and the environment to acceptable levels by meeting the RAOs identified in Section 8.2 in the design and implementation of remedial actions.

In the FS, technology types were screened to narrow the list of technologies that should be considered for more detailed evaluation. As specified by CERCLA guidance, technology types and process options were screened only on the basis of technical feasibility, with no other factors considered. Several remedial technologies, other than the alternatives described in detail later in this section, were screened out. Some examples include soil washing treatment of organic wastes in the fill, horizontal barriers, and extraction and treatment of groundwater.

In the initial screening of the FS, extraction and treatment of groundwater was evaluated; however, groundwater only constitutes a marginal risk and site-specific conditions make extraction and treatment impracticable. Salt water from Sinclair Inlet is intruding on the groundwater. Pumping would increase the intrusion and greatly increase the volume of water to be treated. Chemicals of concern in groundwater mixed with salt water are not readily treatable because of interferences from high concentrations of chemicals naturally found in salt water and dilution of the groundwater contaminants. Treatment of large volumes of groundwater/salt water to the low levels of surface water criteria is impracticable.

Under CERCLA, a no-action alternative must be considered at every site to establish a baseline for comparison. In addition to the no-action alternative, 11 remedial action alternatives were evaluated for OU A. Several of the alternatives can be grouped together, since they differ only in the prescribed area of application (Zones I, II, or III) or in a variation of the method of containment (perimeter stabilized barrier, marine geosynthetic liner, or sheetpiling).

9.1 OPERABLE UNIT A

The five alternative groups evaluated for OU A were:

- Alternative 1—No Action
- Alternative 2—Institutional Controls Plus Upgraded Pavement and Riprap
- Alternatives 3 and 4—Excavation and Disposal
- Alternatives 5A, 5B, and 5C—Waste Stabilization
- Alternatives 6A, 6B, 7A, 7B, and 8—Containment Using Capping, Sheetpiles, or a Geosynthetic Liner

9.1.1 Alternative 1—No Action

This alternative includes no specific response actions to reduce concentrations or exposure to chemicals or to control their migration. It relies solely on natural attenuation mechanisms for migration control or the ultimate degradation of chemicals. Continued erosion of the fill beneath and between the riprap would continue. No actions would be taken to monitor groundwater. The existing pavement would continue to prevent direct contact of workers and visitors with contaminated soils. This alternative has the lowest cost, $21,600 ($21,600 administrative cost and $0 annual operation and maintenance [O&M] cost).

9.1.2 Alternative 2—Institutional Controls Plus Upgraded Pavement and Riprap

Alternative 2 would control human exposure to chemicals of concern in the soils and shellfish by implementing institutional controls through restrictions on residential use, fish and shellfish harvesting, and public access by maintaining fencing and would include monitoring and periodic reviews. Cleanup actions that address marine sediment and ecological receptors in the OU B ROD may supersede those contained in this ROD. Upgrading and maintaining the existing pavement would also be addressed in this alternative. Alternative 2 was augmented from the original presented in the final FS because of the predicted low degree of effectiveness associated with the perimeter containment alternatives. Consequently, this alternative now includes provisions for upgrading the existing riprap and implementing terrestrial and marine habitat enhancements.

Institutional Controls

Institutional controls would involve land use restrictions, restrictions to shellfish harvesting on Charleston Beach and public access, and continuation of existing security measures. Deed restrictions cannot be placed on the property until base closure. Upon base closure, notification of the history of the site would be attached to any property transfer and the property transfer would have to meet the requirements of CERCLA Section 120(h).

Permanent restrictions would be placed on the property by the Navy to limit or prevent development of the fill area or to prevent drilling of water supply wells or use of the groundwater below the site (except for monitoring purposes) and to prevent shellfish harvesting. Absent further cleanup, in the event of transfer of the property, it would be necessary to include deed or use restrictions.

Existing security measures would be continued in order to control physical access to the shoreline of OU A by the general public and Navy personnel. Existing security measures include warning signs for coliform bacteria in shellfish, periodic site inspections by base security, maintenance of the fence that is consistent with facility operations, and a prohibition on fishing and shellfish harvesting. The prohibition on fishing and shellfishing would extend indefinitely. However, these activities may be permitted in the future, pending completion of remedial actions at adjacent OU B. The specific elements of the harvesting prohibitions will be developed under the post-ROD remedial design/ remedial action (RD/RA) work plan.

Pavement Cap

Alternative 2 would also include an upgraded asphalt cap placed over the surface of the existing pavement with an equivalent permeability of 1×10^{-5} cm/sec or less. The cap would be repaired and upgraded over the identified extent of the fill in Zone II (approximately 3.7 acres), as shown on Figure 9-1. Zone II contains by far the most contamination at the site and only limited portions of Zone I show exceedances of MTCA C Industrial levels (location 238 for arsenic and location 261 for TCLP lead). The cap would be designed to meet the following performance criteria:

- Continue adequate surface water collection and drainage with swales, culverts, storm drainage pipes, and catch basins, as needed

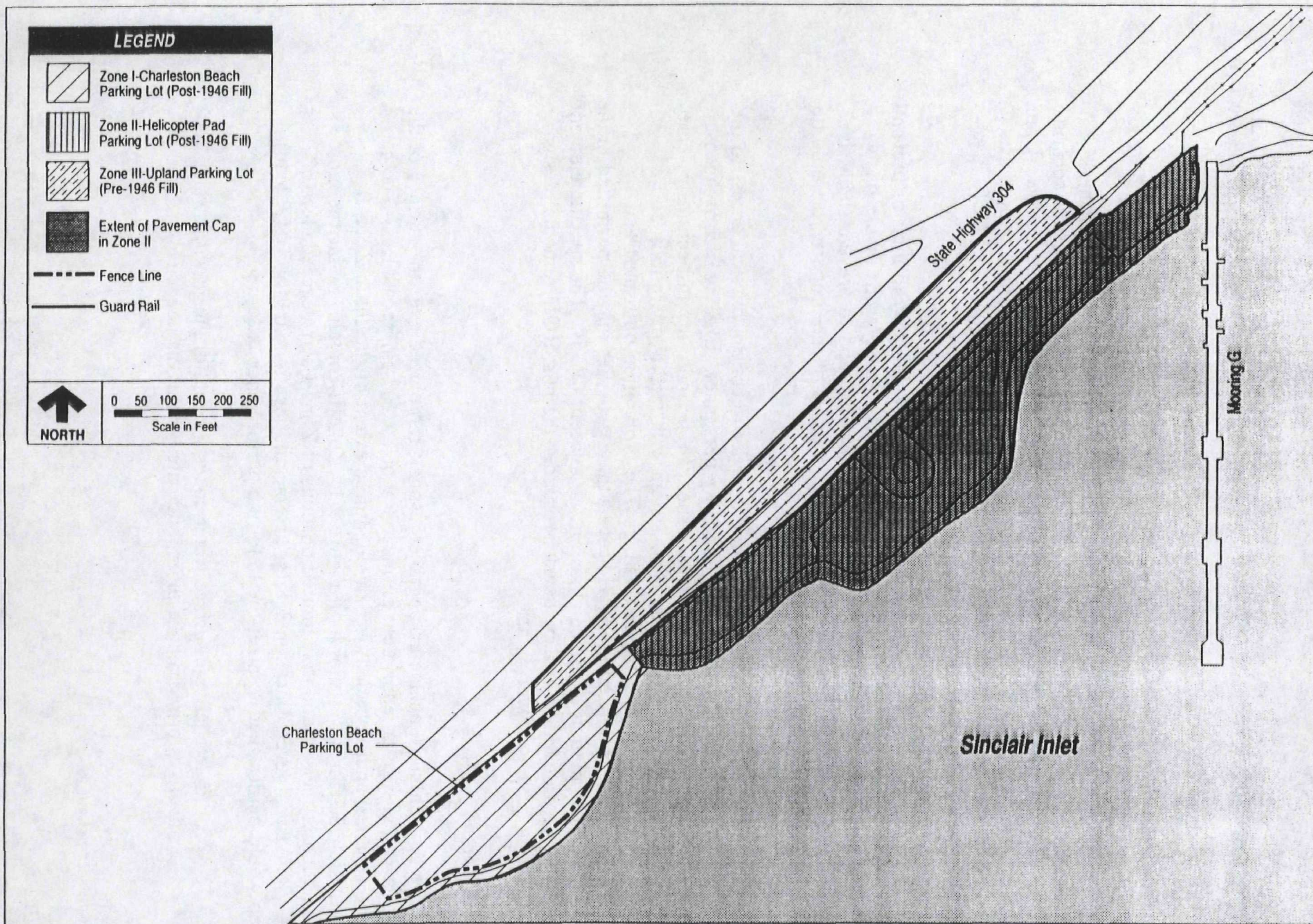

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Figure 9-1
Extent of Pavement Cap in Zone II

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- Minimize exposure of people to soil
- Provide for limited future site uses
- Protect against infiltration of water vertically into the fill
- Implement a plan to repair cracks in the pavement cap caused by settling from voids within the underlying fill material

The proposed design of the cap would include (1) repair of cracks and upgrading of existing pavement, (2) application of a surface sealant coat, and (3) maintenance of proper drainage controls.

The cap would reduce the infiltration and potential for transport of contaminants from soil to groundwater. The cap would also reduce the potential risk associated with metals, PAHs, and PCBs in surface soils by reducing the exposure of human receptors to site soils. The pavement cap would be inspected periodically as part of the monitoring program, and repairs would be made to cracks that may appear in the cap.

Erosion Protection

Erosion protection would reduce the potential for fill debris in the existing riprap to erode into the marine environment; erosion of contaminated fill is likely a source of contamination to adjacent marine waters. The erosion protection alternative will be developed by the Navy with the Washington State Department of Fish and Wildlife and Ecology's Shoreline Program. Erosion protection was selected because (1) it will cover currently visible scrap and fill materials exposed in the existing riprap, (2) it provides better avian and fishery habitat, (3) it reduces maintenance costs, and (4) it provides long-term effectiveness as a result of the expected reduction of groundwater concentrations following placement of the additional riprap or stabilized cobble/gravel layer over the riprap.

Erosion protection would be designed to meet the following performance criteria:

- Withstand a prescribed design storm event
- Minimize human and ecological exposure to eroding fill materials

- Provide for limited future site uses, including parking for Navy personnel and visitors
- Prevent the edge of the fill from eroding into Sinclair Inlet
- Provide pavement grading to maintain adequate surface drainage
- Provide access for operation and maintenance of the parking area
- Limit the amount of marine habitat encroachment

A supply of fresh riprap (approximately 25,000 cubic yards) would be brought in and sloped from the intertidal area inland to ensure continuity with the existing beach habitat. The bank protection would extend approximately 1,400 feet along the perimeter of the fill in Zone II (Figure 9-2). Zone II contains the bulk of contamination at the site and is the only portion that shows visible evidence of fill materials exposed in the existing riprap; therefore, riprap along Zone I is not required. The placement of the fresh riprap would be along the portion of the existing riprap where fill materials or seeps are currently visible. Any excavated materials would be properly disposed of at an off-site landfill. The details of the design will be developed as part of the post-ROD RD/RA phase with input and review from the agencies, the Suquamish Tribe, and the RAB.

After installation of the erosion protection, the shoreline would be examined every spring and after significant storms to monitor the status of the erosion protection. The material provided for the erosion protection may require periodic replacement.

Groundwater Monitoring

Groundwater samples would be collected from nearshore and upgradient monitoring wells and analyzed and reported at least semi-annually for up to 5 years. After reviewing the 5 years of data, the EPA, Ecology, and the Navy would decide on future monitoring requirements.

Measuring chemical concentrations in groundwater at the point of discharge to the marine environment is impractical because of the dynamics of the marine environment. Therefore, groundwater monitoring results from nearshore wells would be compared to surface water standards, with consideration of ambient conditions, to evaluate trends in

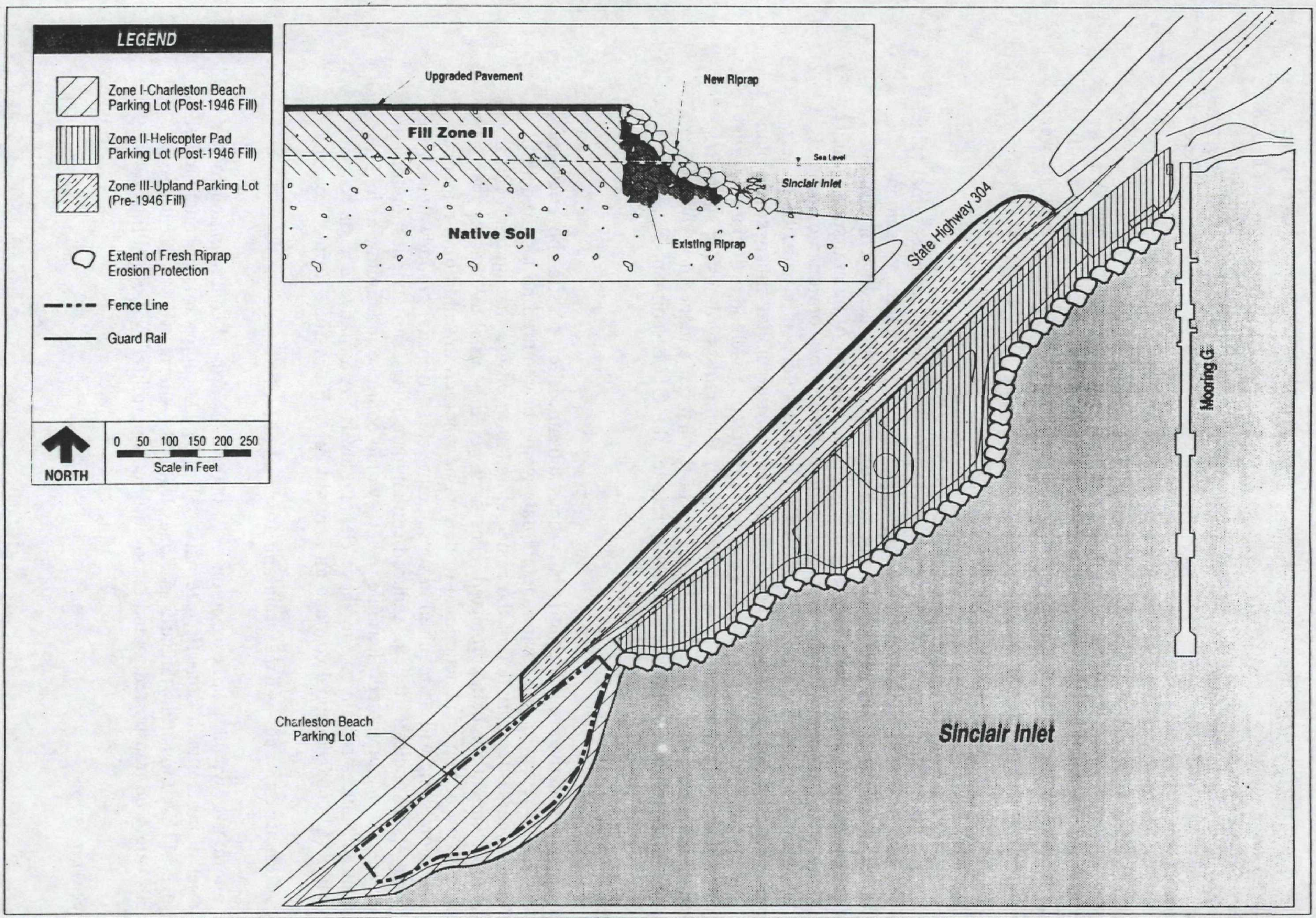

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Figure 9-2
Riprap Protection Along Zone II

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chemical concentrations. If trends in the nearshore wells indicate that chemical concentrations are declining following the remedial action in a manner consistent with long-term attenuation, the monitoring program may be reduced upon agreement between the Navy and EPA and Ecology.

Habitat Enhancements

Low-cost habitat enhancements will be considered to address the existing marginal value of marine and terrestrial habitats now extant on the site, to help augment regional populations of terrestrial and marine species, and to revitalize the ecology of this area. These enhancements will be developed following the completion of habitat surveys and consultation with state agency staff. Implementation will also be coordinated with any remedial alternatives required at OU B and after ongoing studies of circulation patterns within Sinclair Inlet are completed. Possible elements of the habitat enhancement plan to be implemented in conjunction with the erosion protection include artificial intertidal zones, introduced kelp colonies, spawning habitat for salmonids, bird-nesting structures, and vegetated buffer zones. The specific design of the habitat enhancements will be developed in coordination with the RD/RA phase for the OU B sediments.

Periodic Reviews

Because this alternative would result in hazardous substances left on site above levels for unlimited use, a review of the environmental data would be required no less frequently than every 5 years after initiation of the remedial action to ensure that human health and the environment are being protected. The data would be used to evaluate the effectiveness of the remedial action and to determine whether any additional remedial actions or monitoring will be required in subsequent years. If initial groundwater monitoring results indicate static or reduced contaminant levels, subsequent monitoring may be reduced or eliminated. Periodic reviews would continue indefinitely as long as hazardous substances remain on site above cleanup levels. Alternative 2 has a cost of $1.3 million ($1,066,092 capital cost and an annual O&M cost of $66,816 for 5 years).

9.1.3 Alternatives 3 and 4—Excavation and Disposal of Soils

These alternatives would entail excavation of 27,000 cubic yards of contaminated soil in the former disposal pits in Zone II (Alternative 3) to 63,000 cubic yards of contaminated soil above MTCA Industrial standards in Zones I and II (Alternative 4). Excavated materials would be transported to and disposed of at a permitted waste landfill.

Institutional controls, monitoring, periodic reviews, and habitat enhancements would be the same as in Alternative 2. Both alternatives would significantly reduce the volume of contaminated materials at the site. These alternatives have the highest costs of all of the alternatives: $15.9 million for Alternative 3 ($15,685,000 for capital costs and an annual O&M cost of $43,490 for 5 years) and $36.1 million for Alternative 4 ($35,906,000 capital cost and an annual O&M cost of $43,490 for 5 years).

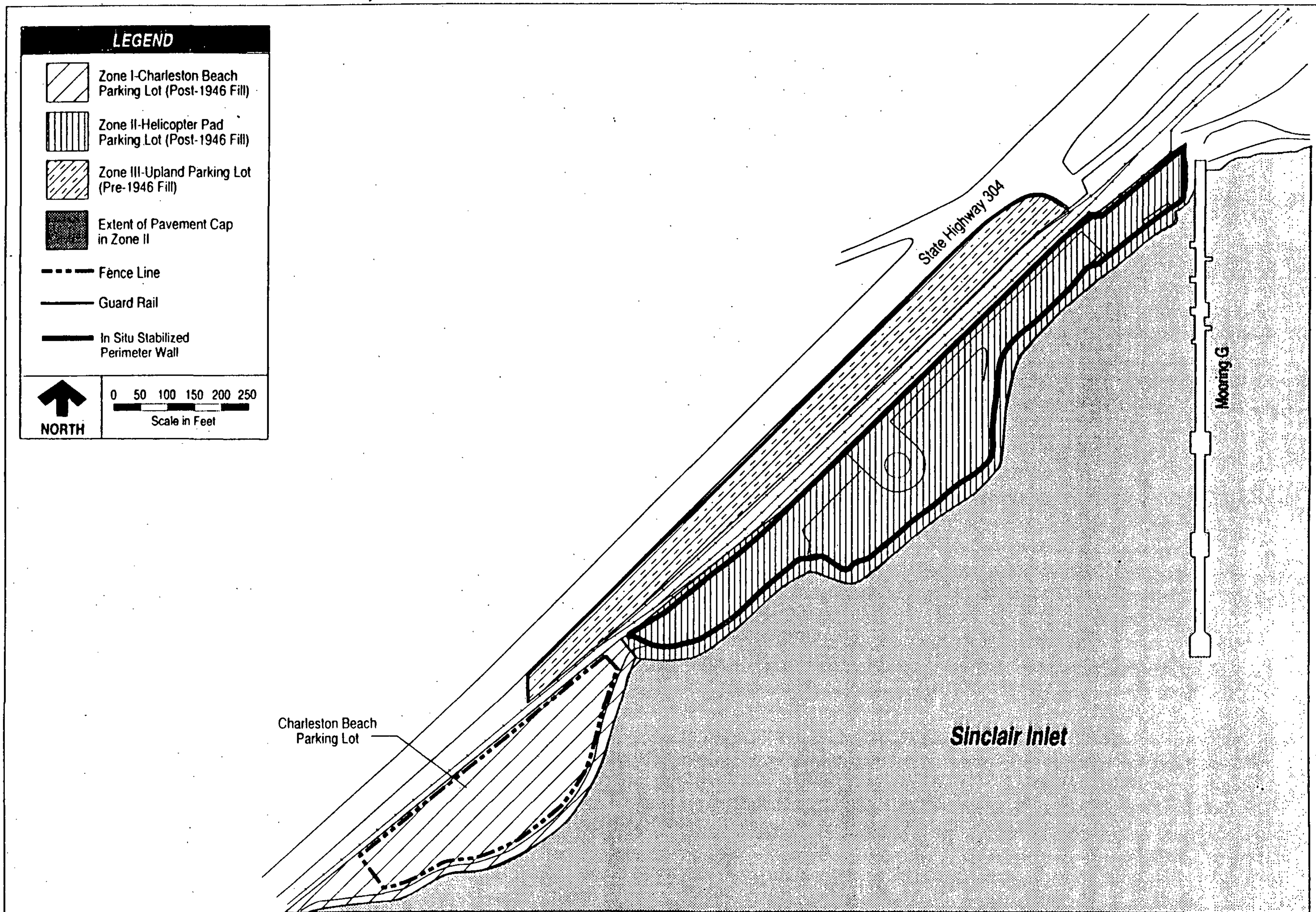
9.1.4 Alternatives 5A, 5B, and 5C—Waste Stabilization

In this group of alternatives, contaminated soils in Zones I and II would be stabilized in the ground or excavated, mixed with cementing agents, and disposed of on site. The stabilizing agents would likely involve a cement-based additive to ensure that the resulting treated wastes would be structurally sound and remain chemically inert. The alternatives include institutional controls, monitoring, and habitat enhancement as described in Alternative 2. Alternative 5A involves excavation and on-site stabilization of soils in Zones I and II; Alternative 5B involves in situ stabilization of soils in Zones I and II; Alternative 5C involves the stabilization of soil only around the perimeter of Zone II and "hotspot" soils in Zone I (Figure 9-3). These stabilization and containment options were developed to address the concern for controlling the discharge of chemicals in groundwater from the site.

The costs of these alternatives range from approximately $4.4 million for Alternative 5C (capital cost of $4,171,000 and an annual O&M cost of $43,490 for 5 years) to $21.0 million for Alternative 5A (capital cost of $20,808,000 and an annual O&M cost of $43,490 for 5 years) and $9.5 million for Alternative 5B (capital cost of $9,294,000 and an annual O&M cost of $43,490 for 5 years).

9.1.5 Alternatives 6A, 6B, 7A, 7B, and 8—Containment Using Capping, Sheetpiles, or a Geosynthetic Membrane

This group of five alternatives addresses isolation of contaminated soils and containment of site groundwater through various combinations and types of barriers: cap and sheetpiles for Zones I and II (Alternative 6A), cap and sheetpiles for Zone II (Alternative 6B), cap and geosynthetic liner for Zones I and II (Alternative 7A), sheetpiles and geosynthetic liner for Zone II (Alternative 7B), and an upland sheetpile barrier for Zones I and II (Alternative 8). These alternatives include institutional controls, monitoring, and habitat enhancements as described for Alternative 2. Estimated costs for these alternatives are $6.8 million for Alternative 6A (capital cost of



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 9-3** **Extent of In Situ Stabilized Perimeter Wall for Alternative 5C**	CTO 0160 PSNS OU A Bremerton, Washington FINAL ROD

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$6,517,000 and an annual O&M cost of $67,000 for 5 years), $4.8 million for Alternative 6B (capital cost of $4,574,000 and an annual O&M cost of $51,000 for 5 years), $6.2 million for Alternative 7A (capital cost of $5,926,000 and an annual O&M cost of $54,300 for 5 years), $4.7 million for Alternative 7B (capital cost of $4,508,000 and an annual O&M cost of $43,490 for 5 years), and $2.2 million for Alternative 8 (capital cost of $2,027,000 and an annual O&M cost of $43,490 for 5 years).

10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The EPA has established nine criteria for the evaluation of remedial alternatives:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

The following sections evaluate the five sets of alternatives according to the nine EPA evaluation criteria. Each remedial alternative is discussed in terms of the evaluation criteria to help identify a preferred alternative for OU A. The no-action alternative (Alternative 1) was included as a baseline comparison.

10.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The primary human health risks at OU A are to potential future residents and future industrial workers from exposure to soils contaminated with metals and to subsistence consumers of fish and shellfish. The primary ecological risks are to shellfish, fish, and birds through exposure to sediments contaminated with metals, PCBs, and pesticides, and theoretically through bioaccumulation up the food chain. Direct action to remediate the sediments may be undertaken under the OU B ROD. However, alternatives were developed in this ROD for the terrestrial portion of OU A to reduce a potential source of sediment contamination.

The risk from on-site soils can be attributed to contaminants found in the fill. Groundwater at OU A was found to exceed some surface water cleanup standards for PAHs, pesticides, SVOCs, and inorganics. Groundwater is not a source of drinking water because tidal influence renders it not potable. Based on available information, groundwater modeling indicated that groundwater is currently not a significant source of contamination to Sinclair Inlet; however, it likely provided a contaminant pathway to the marine environment in the past. If OU B RI results show that further groundwater remedial measures are appropriate, such measures will be defined in the OU B ROD.

Alternative 1 (the no-action alternative) would not prevent exposures of concern. The pavement provides marginal protection for human health and the environment. Because Alternative 1 would not provide adequate overall protection of the environment and does not meet this threshold criterion, it is eliminated from further consideration and is not included in the following sections that discuss the remaining evaluation criteria.

Alternative 2 (institutional controls plus upgraded pavement and riprap) would not reduce or eliminate contaminants in the soil or groundwater. However, this alternative would (in the context of risk management of the site) reduce exposure to contaminants in the soil; reduce erosion of fill materials into Sinclair Inlet; control harvesting of shellfish through warning signs and public education; reduce exposure to waste materials in the fill contents by implementing institutional controls (land use restrictions on residential use, shellfish harvesting, and public access, and continued existing security measures), monitoring, and periodic reviews; and enhance existing terrestrial and marine habitat.

Alternatives 3 and 4 (excavation and disposal) are the most protective alternatives, since contaminated soil would be removed from the site. Institutional controls, monitoring, and habitat enhancement would have the same benefits of exposure reduction as the other alternatives.

Alternatives 5 through 8 provide protection by reducing direct contact through capping, subsurface stabilization, and access restrictions. However, the treatability studies and groundwater modeling have shown that subsurface stabilization and groundwater containment barriers addressed in these alternatives would be only minimally effective and would be difficult to implement. Therefore, the additional components would increase protectiveness only marginally.

10.2 COMPLIANCE WITH ARARs

Section 12.2 lists the ARARs specific to Alternative 2. Contaminant concentrations in soils exceeded MTCA Method C Industrial screening levels and groundwater exceeded surface water criteria. Contaminant concentrations in marine sediments and biota adjacent to the site exceeded SMS and risk-based levels. The contamination of the marine environment may be a result of several sources, including historical direct discharge of liquid wastes, erosion of the fill material, and past groundwater flow. Groundwater chemical flux modeling appears to show low contaminant levels currently being discharged to Sinclair Inlet. However, if further analysis at OU B indicates a need for further actions, those actions would be defined under the ROD for OU B.

The no action alternative fails to meet ARARs, since no action would be performed to directly reduce the contamination or exposure to the contamination. For Alternatives 3 and 4, ARARs would be attained through excavation and off-site disposal of the most contaminated soils. ARARs are met for Alternatives 2 and 5 through 8 by reducing exposure through various combinations of capping and stabilization and institutional controls.

10.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternatives 3 and 4 represent the highest level of long-term effectiveness and permanence, since the most contaminated soil is physically removed from the site. The surface capping included in Alternatives 2, 6, and 7 and the surface portion of the stabilization in Alternatives 5A and 5B is effective in preventing direct contact and would remain effective so long as the cap is maintained through ongoing inspections, and repairs and institutional controls are in place to prevent breaching of the cap. Institutional controls included in all the alternatives should be effective at limiting access and preventing residential use. Groundwater modeling has shown that groundwater containment (e.g., in Alternatives 5C and 6 through 8) would be only minimally effective due to lack of a confining layer and the rate of groundwater flow. Three-dimensional flow modeling was conducted to determine whether such a containment system could be effective, given the hydrogeologic and subsurface conditions at the site. These model simulations suggest that under site conditions, a perimeter containment system would reduce the existing flow by 25 to 60 percent and reduce marginal site risks associated with groundwater by a factor less than 10. OU A does not exhibit uniform subsurface conditions due to the underlying heterogeneous fill material and lacks a continuous thin bay mud layer underlying the fill.

10.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Alternative 2 would not reduce the toxicity or volume of contaminants. Although Alternative 2 reduces mobility, the stabilization/containment included in Alternatives 5A, 5B, and 5C would reduce the mobility of the contaminants in soil and groundwater to a greater extent. Implementing Alternatives 5A, 5B, and 5C, however, would increase the volume of contaminated soil. The other alternatives rely on containment to reduce mobility.

10.5 SHORT-TERM EFFECTIVENESS

None of the alternatives would likely pose health risks during implementation. Workers and base personnel would be protected during construction by engineering and safety controls. Alternative 1 could be implemented immediately after the ROD is signed.

Unavoidable short-term ecological impacts would occur under Alternatives 2, 3, 4, 5A, 5B, 6A, 6B, 7A, and 7B because of construction associated with erosion protection, excavation, waste stabilization, or the installation of containment barriers. The impacts include temporary disruption of habitat and destruction of existing benthic organisms along the shoreline and shallow marine environment, with only minor effects associated with Alternative 2. It is expected that the benthic organisms would repopulate and establish a healthier community. Alternative 2 is estimated to take 3 months for construction; Alternatives 5C, 6A, 6B, 7A, 7B, and 8 are estimated to take 6 months for construction. Alternatives 3, 4, 5A, and 5B are estimated to take 9 months for construction because of the large excavation volumes involved.

10.6 IMPLEMENTABILITY

Alternative 2 can be readily implemented. Alternatives 3 and 4 can be readily implemented using existing technology and readily available equipment. Alternative 5C, involving a perimeter barrier constructed from stabilized fill, was previously the recommended alternative because of its associated cost, its provision for treatment of some of the most contaminated soils, and its presumed effectiveness as a containment alternative for Zone II fill materials. However, groundwater modeling simulations suggest that the subsurface conditions at Zone II would not be conducive to effective containment of groundwater. Furthermore, a constructibility study conducted by the remedial action contractor in January 1996 suggested that conditions at the site are not uniform and that large subsurface obstructions and voids likely exist. These conditions would have the effect of significantly increasing construction costs and potentially reducing the effectiveness of the containment. The result is that it would require a significantly expensive remedial design to contain groundwater flow from the site. Because of the heterogeneous nature of the fill material, the alternatives involving stabilization (Alternatives 5A, 5B, and 5C) and subsurface containment barriers (Alternatives 5C, 6, 7, and 8) would be difficult to implement.

10.7 COST

The capital cost for Alternative 1 (no action) represents administrative cost as well as the cost of the 5-year review of the alternative and equals $21,600. The estimated present-worth costs of Alternatives 2, 3, 4, 5A, 5B, 5C, 6A, 6B, 7A, 7B, and 8 are summarized in Table 10-1.

These cost estimates were prepared using costing techniques that typically achieve an accuracy of +50 percent to -30 percent for a specified scope of actions. Also, the cost estimates were based on 5 years of operation at an annual discount rate of 5 percent. Most of the alternatives may require monitoring and maintenance beyond 5 years (Table 10-1).

10.8 STATE ACCEPTANCE

Ecology has been involved with the development and review of the RI, FS, proposed plan, and ROD. Ecology's participation has resulted in substantive changes to these documents. Ecology does not support the selection of (1) Alternative 1 because it offers no protection to the environment, (2) Alternatives 3 and 4 because of high implementation costs and the potential for mobilizing additional contaminants to Sinclair Inlet, and (3) Alternatives 5A, 5B, 5C, 6A, 6B, 7A, 7B, and 8 because of concerns regarding the level of effectiveness and constructibility. Ecology concurs with the selection of Alternative 2 for OU A.

Table 10-1
Summary of Costs for Remedial Alternatives at Operable Unit A

Alternative/Process Options	Capital Costs ($)	Annual O&M[a] ($)	Total Present Worth ($)
1—No Action	21,600	0	21,600
2—Institutional Controls and Upgraded Pavement and Riprap	1,066,092	66,816	1,355,000
3—Excavation from Disposal Pits	15,685,000	43,490	15,873,000
4—Excavation from Zones I and II	35,906,000	43,490	36,094,000
5A—On-Site Stabilization of Zones I and II Soils	20,808,000	43,490	20,996,000
5B—In-Place Stabilization of Zones I and II Soils Exceeding Cleanup Levels	9,294,000	43,490	9,482,000
5C—On-Site Stabilization of Zone I "Hotspot" Soils and the Perimeter of Zone II	4,171,000	43,490	4,359,000
6A—Cap and Sheetpiles for Zones I and II	6,517,000	67,000	6,804,000
6B—Removal of Zone I "Hotspot" Soils and Cap and Sheetpiles for Zone II	4,574,000	51,000	4,795,000
7A—Cap and Lining for Zones I and II	5,926,000	54,300	6,161,000
7B—Removal of Zone I "Hotspot" Soils and Sheetpiles and Lining for Zone II	4,508,000	43,490	4,696,000
8—Sheetpile Barriers Upland of Zones I and II	2,027,000	43,490	2,215,000

[a]Assuming operation and maintenance for 5 years at 5 percent discount factor.

10.9 COMMUNITY ACCEPTANCE

A responsiveness summary of the comments is provided in Appendix A of this document.

The issues that were discussed during the public meeting and in subsequent written comments included:

- Risk assessment methodology
- Rationale for addressing groundwater in the proposed remedy
- Results of the groundwater modeling
- Screening criteria and frequency of groundwater monitoring
- Evaluation of the proposed remedy for OU A in light of the ongoing RI at OU B
- Other potential non-Navy sources of contamination in Sinclair Inlet
- Tribal concerns about the inclusion of fish and shellfish harvesting restrictions and habitat enhancements in the proposed plan
- Concerns about the ecological risks, groundwater contaminant levels, and details of fish and shellfish restrictions; monitoring; habitat enhancement; and public education and involvement

None of the issues identified resulted in changes to the preferred alternative.

11.0 THE SELECTED REMEDY

Based on consideration of CERCLA requirements, analysis of alternatives using the nine evaluation criteria, and public comments, the Navy, Ecology, and the EPA have determined that Alternative 2 (institutional controls plus upgraded pavement and riprap [erosion protection]) is the most appropriate remedy at PSNS OU A. This is the best alternative for the following reasons:

- The site is industrial and it is expected to remain as such.
- The risks from exposure to fill materials are minimal given adequate maintenance of the asphalt pavement and site security.
- The costs of implementing excavation, containment, or treatment options are substantial, and these costs are disproportionate to the incremental improvement in human health or the environment.
- Due to site-specific conditions, containment of the groundwater would not be highly effective and would be difficult to implement.

The Navy and the agencies have agreed that if groundwater modeling and ecological risk assessment performed for OU B indicate a need for further action at OU A to protect marine resources, those measures and any additional monitoring will be defined in the ROD for OU B.

The combination of institutional controls (i.e., land use restrictions for residential use and fish and shellfish harvesting), monitoring groundwater, upgrading the pavement cap, providing erosion protection along a portion of the existing riprap and shoreline, and enhancing habitat best achieves the RAOs established for OU A. The specifics of implementing the institutional controls for the site will be determined by agreement between the Navy, EPA, Ecology, and the community (RAB) during the RD phase.

The cap will be upgraded and sealed over the existing pavement surface. The cap is protective of human health and the environment. Future construction and maintenance of facilities at OU A may require breaching of the asphalt concrete cap; workers could then be exposed to contaminated soil. The Navy will develop and implement a soil management plan that will apply to all future excavation projects at the Bremerton Naval Complex. The plan will require interaction with Navy management prior to any excavation activity, and ensure that any excavated soils are sampled and analyzed, handled properly, and disposed of appropriately. The selected remedy provides a high potential for reaching the goals of reducing potential risks to humans and the environment to acceptable levels and for improving terrestrial and marine habitat.

The major components of the selected remedy for OU A are the following:

- Upgrading the pavement cap over approximately 3.7 acres.

- Placing erosion protection (additional riprap or stabilized cobble/gravel layer) along approximately 1,400 linear feet of the existing shoreline. If placement of erosion protection causes there to be a net loss of productive capacity of fish and shellfish habitat, mitigation measures will be incorporated into the project. Appropriate mitigation measures will be determined after close consultation with interested parties and in accordance with ***the substantive requirements*** of the Hydraulic Code, Chapter 220-110 WAC, prior to the placement of erosion protection.

- Implementing institutional controls, which include fencing (such as already exists), warning signs, an extended prohibition on fish and shellfish harvesting at Charleston Beach, and land use restrictions on residential use. Residential restrictions and controls and requirements for the inspection and maintenance of the pavement cap and erosion protection will be implemented with a Bremerton Naval Complex-wide soil management plan.

- Conducting a groundwater monitoring sampling and analysis program.

- Conducting a periodic review of the data no less frequently than every 5 years. At the 5-year review, all data will be evaluated by the Navy, Ecology, and the EPA to assess the protectiveness associated with reduction of risks to the human health and ecological receptors in the marine environment, as well as the need for any further action.

- Creating a monitoring program that examines and reports on all elements of the remediation.

- Conducting regular inspection and maintenance of the pavement cap and erosion protection, particularly after storms.

- Implementing marine and terrestrial habitat enhancements.

Groundwater monitoring results will be compared to surface water standards (see Section 8.3) to evaluate trends in chemical concentrations. If the results of the groundwater sampling indicate compliance with surface water standards (and in consideration of background levels) or if trends in nearshore sampling points are declining in a manner consistent with long-term attenuation, monitoring may be reduced upon agreement between the Navy, EPA, and Ecology.

Actions at OU A will also include compliance with a future Bremerton Naval Complex-wide soil management plan and a facility-wide petroleum cleanup program.

Pursuant to Section 120(h)(1) of CERCLA and Part 373 of the NCP, should the United States enter into a contract for the sale or other transfer of OU A property, the United States would give notice of hazardous substances that have been stored, disposed of, or released on the property. Pursuant to Section 120(h)(3) of CERCLA the United States would include in each deed entered into for the transfer of the property a covenant stating that the remedial action(s) are completed and any additional remedial action found to be necessary after the transfer shall be conducted by the United States. In addition to the covenants required by Section 120(h) of CERCLA, the Navy is seeking GSA approval of restrictive covenants/deed restrictions to effectuate the ROD, which will be included in the conveyance document in the event of transfer of the property to a nonfederal entity. The conveyance document shall require the nonfederal transferee to record the restrictive covenants/deed restrictions with the county auditor within 30 days of transfer. Such covenants/deed restrictions will address any limits to remain in effect after the time of transfer to restrict land use, restrict the use of groundwater, and manage excavation. The deed covenants will also include provisions addressing the continued operation, maintenance, and monitoring of the selected remedy. In the event that GSA does not approve the restrictive covenants/deed restrictions by the time of the 5-year review, the ROD may be reopened.

If at any time following the signing of this ROD, the Navy, EPA, and Ecology determine that there is a serious impact to Sinclair Inlet resources, the Navy and the agencies may decide to investigate potential sources of contamination or treat contaminated sources or groundwater. Such actions will be taken only after appropriate public involvement and after this ROD is re-evaluated. These efforts will need to be coordinated with concurrent remediation and monitoring at OU B.

12.0 STATUTORY DETERMINATIONS

Under CERCLA, selected remedies must protect human health and the environment, comply with ARARs, be cost-effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that use treatments that significantly and permanently reduce the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy for OU A meets these statutory requirements.

12.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedial action for OU A will protect human health and the environment through the upgrading and maintenance of the pavement cap over the contaminated fill in Zone II, erosion control by upgrading the riprap, habitat enhancement, O&M activities, and institutional controls. Periodic inspections of the remedial measures will confirm that the selected remedy remains protective. If the OU B RI/FS indicates a need for further action at OU A to protect marine resources, those measures and any additional monitoring will be defined in the ROD for OU B.

The upgraded pavement cap will protect humans and the environment from direct exposure to the contaminants in the fill. In addition, it will reduce the migration of contaminants to Sinclair Inlet by minimizing infiltration from precipitation flowing through the fill. Long-term effectiveness of the cap will be provided through regular inspection and maintenance.

Erosion protection will reduce the erosion of contaminated fill materials into the marine environment during storms. Long-term effectiveness of the erosion protection will be provided through regular inspection and maintenance.

Active groundwater treatment or containment is not being performed for several reasons: (1) the absence of a demonstrated link between contaminant levels in groundwater and marine sediments, (2) problems of effectiveness of containment without a confining layer, (3) problems with constructability given the nature of the fill materials, and (4) the impracticability of achieving some of the water quality standards by conventional treatment methods. Groundwater monitoring will help to verify that groundwater contaminants are not significantly affecting marine waters in Sinclair Inlet.

Groundwater monitoring will be initiated to detect potential releases to the marine environment and to determine whether the contaminant levels in groundwater are being reduced through capping, placement of riprap, and natural processes. Implementing institutional controls will restrict future residential land use at the site, prevent the public from harvesting nearby shellfish, and minimize the potential for activities at or near the surface of the site that could disturb the integrity of the pavement cap. Absent further cleanup, in the event of transfer of the property, it would be necessary to include deed or use restrictions in the conveyance documents.

12.2 COMPLIANCE WITH ARARs

The selected remedy for OU A will comply with federal and state ARARs that have been identified. No waiver of any ARAR is being sought or invoked for any component of the selected remedies. The chemical-, action-, and location-specific ARARs identified for the site follow.

- Regulations implementing MTCA (RCW 70.105D and WAC 173-340), which establishes cleanup standards for soil, groundwater, and surface water and requires institutional controls and compliance monitoring where hazardous substances have been detected and remain on site after remediation, are applicable.

- State of Washington SMS (WAC 173-204) are applicable because they establish all the requirements to control potential sources of contaminants to marine sediments. By agreement among the Navy, EPA, and Ecology, all marine sediment issues will be addressed in OU B.

- State of Washington Water Quality Standards for Surface Water (WAC 173-201A) and Washington Water Pollution Control (RCW 90.48) standards are applicable because (1) they establish use classification and water quality standards for marine water for the protection of public health, fish, shellfish, and wildlife and (2) groundwater discharges to Sinclair Inlet.

- Federal Water Quality Criteria (Federal Water Pollution Control Act, Section 303 and 40 CFR 131) are relevant and appropriate because (1) they establish marine water criteria for the protection of aquatic life and (2) groundwater discharges to Sinclair Inlet. The National Toxics Rule found in 40 CFR 131 addresses the risk to human health from the consumption of aquatic organisms and is considered an applicable requirement.

- Washington Minimum Standards for construction and maintenance of wells (WAC 173-160) require that measures be implemented to protect groundwater from sources of contamination during well construction. This regulation is applicable at the site because of possible additional monitoring wells that may be constructed at OU A. This regulation is also applicable for well abandonment procedures.

- Washington Dangerous Waste Regulations (WAC 173-303) establish procedures for the designation of waste as dangerous and standards for handling, transporting, storing, and treating the designated waste. These regulations are applicable to the uncontained fill debris that may be collected and transported off site during the remedial action.

- Washington Transportation of Hazardous Waste Materials (WAC 446-50) concerns the transportation of hazardous materials and wastes on the public highways of Washington state. The regulation is designed to protect persons and property from unreasonable risk or harm or damage from incidents or accidents resulting from hazardous materials and wastes. The regulation is applicable if it becomes necessary to remove and dispose of hazardous materials during the remedial action at OU A.

- The Washington Hydraulic Code (RCW 75.20.100-140 and WAC 220-110) specifies that a state permit is required for projects that will use, divert, obstruct, or change the natural flow or bed of state waters, and that actions will be taken to protect fish and fish habitat from damage by construction activity. This regulation is relevant and appropriate because construction of the erosion protection system will occur within the ordinary high-water mark, or if it is determined that a fishery resource or habitat would be altered with the placement of the erosion protection into the marine environment. With respect to the Washington Hydraulic Code, permits would not be required if the cleanup activities are conducted entirely on site, but substantive requirements would be applicable if the marine environment is affected.

- The Shoreline Management Act of 1971 (RCW 90.58 and WAC 173-016) is applicable for the erosion protection to be used along the riprap shoreline. The shoreline of OU A at extreme low tide qualifies as a shoreline of statewide significance. Local master programs in the vicinity of the shipyard under the Shoreline Management Act actively promote aesthetic considerations during general enhancement of the shoreline area, protect the resources and ecology of the shorelines, and increase recreational opportunities for the public on the shorelines. The Shoreline Management Act also states that shoreline fill, such as the erosion protection, will be designed and located so that significant damage to existing ecological values or natural resources does not occur and that all fill material should be of such quality that it will not cause water quality problems.

- The Coastal Zone Management Act in Section 307(c)(1) requires that the lead agency (the Navy) determine whether the remedial alternative at OU A is consistent to the maximum extent practicable with the state coastal zone management program and notify the state within 90 days of its determination. This regulation is considered applicable because erosion protection will be used along the shoreline at OU A. The State has delegated coastal zone management consistency determinations to the City of Bremerton.

- The federal Clean Air Act, Washington Clean Air Act, and Regulations per Puget Sound Air Pollution Control Agency (42 USC 7401, RCW 70.94, WAC 173-400-040, and Puget Sound Air Pollution Control Agency [PSAPCA] for fugitive dust are applicable during construction.

- The Endangered Species Act (16 USC 1531, promulgated by 33 CFR 320-330) is relevant and appropriate to OU A in general, because bald eagles are known to inhabit the vicinity of the shipyard throughout Kitsap County. However, the actions of the selected remedy at the site will not affect critical habitat of this species.

12.3 OTHER CRITERIA, ADVISORIES, OR GUIDANCE

This section discusses other criteria, advisories, or guidance considered to be appropriate for the remedial actions of the selected remedy for OU A.

Federal OSHA regulations are applicable to workers involved in any site remediation activities that involve potential worker contact with a hazardous substance.

State of Washington Industrial Safety and Health Act Occupational Health Standards—Safety Standards for Carcinogens (WAC 296-62) concerns the protection of human health of workers by prescribing minimum requirements for the prevention or control of conditions hazardous to health.

The State of Washington's *Statistical Guidance for Ecology Site Managers* (Ecology 1992a) and Supplement 6 to this guidance (Ecology 1993) are to be considered for the purpose of interpreting the sampling and analysis results at OU A.

The State of Washington's *Stormwater Management Manual for the Puget Sound Basin* should be considered for stormwater control systems (Ecology 1992b).

12.4 COST-EFFECTIVENESS

The selected remedial alternative for OU A is the least costly alternative after no action. Alternative 2 is protective of human health and the environment and attains ARARs, with risk reduction proportional to its cost.

12.5 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES OR RESOURCE RECOVERY TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

The selected remedy for OU A represents the maximum extent to which permanent solutions can be utilized in a cost-effective manner. It is protective of human health and the environment, complies with ARARs, and provides the best balance of tradeoffs in terms of long-term effectiveness, permanence, short-term effectiveness, implementability, cost, and reductions in toxicity, mobility, or volume. The selected remedy meets the statutory requirements for using permanent solutions to the maximum extent practicable.

Treatment is not part of the remedy for the fill, and it is not anticipated that any resource recovery technologies (e.g., recycling) will be used at OU A.

By upgrading and maintaining a cap over the fill and upgrading the riprap and implementing institutional controls, the selected remedy at OU A will provide a long-term and cost-effective solution relative to the other alternatives.

12.6 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

The only type of treatment evaluated for OU A was solidification and stabilization of soils. Solidification and stabilization were determined to be impractical due to implementation difficulties and limited effectiveness caused by the heterogeneous nature of the fill material. Therefore, the selected alternative does not include treatment. Exposure is reduced by maintaining a cap and providing erosion controls along the shoreline.

13.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The proposed plan released for public comment in May 1996 discussed remedial action alternatives for OU A. The proposed plan identified Alternative 2 (pavement cap, riprap erosion protection, habitat enhancements, and restrictions on land use, fishing, and shellfishing [institutional controls]) as the preferred alternative for OU A. The Navy reviewed all written and oral comments submitted during the public comment period for OU A. Upon review of these comments, it was determined that no significant changes to the remedy for OU A, as it was originally identified in the proposed plan, were necessary to satisfy public concerns.

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APPENDIX A

Responsiveness Summary

RESPONSIVENESS SUMMARY
PSNS OPERABLE UNIT A

This responsiveness summary addresses public comments received on the proposed plan for remedial action at Puget Sound Naval Shipyard (PSNS) Operable Unit A (OU A). Several questions were asked at the public meeting held on May 28, 1996, at the Washington Mutual Building in Bremerton, Washington. Where possible, immediate responses were provided. One formal comment was also provided during the meeting by Mr. Richard Brooks, representing the Suquamish Tribe. Three written comments were also submitted—one prior to the meeting and two following the meeting.

The questions, comments, and responses provided during the meeting are summarized below. A complete transcript of the of the public meeting is available in the information repository, which is located at three libraries in the vicinity of the site: the Central Library and the Downtown Branch Library in Bremerton and the Port Orchard Library in Port Orchard.

1. **Comment:** (oral comment from Mr. Kal Leichtman at the public meeting) *How are the [risk assessment chemicals and numbers] determined?*

Response: The carcinogenic and noncarcinogenic risks are calculated using mathematical formulas. The formulas relate the concentration of chemicals in environmental media (e.g., soils, groundwater, and marine sediments and tissue) to excess cancer risks and noncancer risks to current site users and hypothetical future individuals. Scenarios included site walkers, utility workers, future residents, and future fishers and shellfishers. The risk assessment procedure follows U.S. Environmental Protection Agency (EPA) guidance. The same type of analysis is performed for potential ecological receptors, including marine organisms and birds that feed upon them.

2. **Comment:** (oral comment from Mr. Richard Brooks at the public meeting) *The table [on the poster board] there is a little different from the information in your proposed plan. It indicates that subsistence consumers of fish and shellfish would have an unacceptable risk due to concentrations of PCBs and pesticides. There [on the poster board] it indicates that future shellfishers and future fishers have marginal human health effects.*

Response: The results presented at the Proposed Plan public meeting summarized those included in the RI. The risks to future fishers and shellfishers were within EPA's range of acceptable risk. In discussions held prior to finalizing the final remedial investigation (RI) report, we were advised to evaluate the risk to subsistence future shellfishers and fishers subject to a higher level of consumption, based on studies by the tribes in the area. These additional scenarios resulted in higher risks by approximately five fold.

3. **Comment:** (oral comment by Mr. Kal Leichtman at the public meeting) *How about some of the other debilitating illnesses due to ingesting some of the contaminants?*

Response: The scenarios evaluated in the risk assessment estimate the incremental probability of contracting cancer and/or other noncancer effects related to exposure to toxic chemicals. The likelihood of noncancer effects is determined by calculating a hazard index (HI). When a calculated HI exceeds 1, systemic effects to specific body tissues are predicted.

We look at exposure of humans over a long period of time. Under a residential scenario, it is usually 30 years. We look at both the toxic and carcinogenic effects.

4. **Comment:** (oral comment by Ms. Connie Lewis and Mr. Kal Leichtman at the public meeting) *Could you explain what riprap is?*

Response: Riprap consists of large blocks of rock (or quarry spalls) used for bank protection.

The rock has to be of a certain quality and a certain size that maintains the erosion protection of the bank and also is stable through time under wetting, drying, freezing, and thawing processes. Specifications for the riprap will be determined in the remedial design phase.

5. **Comment:** (oral comment by Mr. Kal Leichtman at the public meeting) *If the groundwater has already leached the contaminants [in the fill], why bother with it now?*

Response: In some parts of the riprap, there are visible areas of industrial fill, such as scrap metal and metal shavings. There is a potential during storms and even during normal tidal action for that material to slough into Sinclair Inlet. The proposed alternative would be a way to keep that material from moving directly into Sinclair Inlet.

6. **Comment:** (oral comment by Mr. Rich Yanss at the public meeting) *I was also a little bit confused over the fate and transport chart. I don't remember it being presented that way in either the feasibility study or remedial investigation. It seems a relatively new view towards that information.*

Response: The chart summarizing the effectiveness of the proposed groundwater containment alternatives referred to a groundwater modeling study that was conducted after the feasibility study, so it has not been presented to the Restoration Advisory Board (RAB) before. The results of the modeling suggest that the containment remedy would be marginally effective, resulting in only a 25 to 60 percent reduction in groundwater flow to Sinclair Inlet.

7. **Comment:** (oral comment by Mr. Rich Yanss at the public meeting) *The implication [of this study] was that most of the contaminants have already leached out...We're only talking about certain types [of contaminants]. Certainly the heavy metals still remain there [in the fill].*

Response: The heavy metals do remain in the fill, but the amount that can be leached out is much lower than the total. The contaminants in most parts of the fill are strongly adsorbed to the soil particles and are not easily leached out into groundwater. For dissolved metals, we see low parts per billion levels in groundwater, compared to much higher levels in soils.

8. **Comment:** (oral comment by Mr. Rich Yanss at the public meeting) *Would that be more typical of slag materials or things of that nature?*

Response: It would be typical of a situation where leaching of contaminants in the fill has occurred over a period of decades and most of the available and mobile metals have been flushed out of the site.

9. **Comment:** (oral comment by Mr. Kal Leichtman at the public meeting) *Will the questions and answers that have been presented now constitute part of the [Record of Decision]?*

Response: Yes. Any questions or comments get incorporated into the responsiveness summary in the Record of Decision.

10. **Comment:** (oral comment by Mr. Rich Yanss at the public meeting) *We're saying that over a period of years, most of the [leaching of the] contaminants, due to both groundwater flow and tidal action, have already occurred.*

Response: Yes, and in the past, the contaminants were also transported to Sinclair Inlet by disposal (e.g., flushing of plating waste). The Navy will continue to monitor groundwater to confirm the low current rate of chemical transport in groundwater.

11. **Comment:** (oral comment by Mr. Rich Yanss at the public meeting) *And it would be action, primarily of keeping the area blacktopped...[and the site] would keep releasing ...material to the bay, but it certainly won't stop any contaminant leaching from tidal action.*

Response: That's correct. However, again it is likely that releases via groundwater were higher in the past. For example, there is no mercury detected in the most recent groundwater samples. Contaminants are now observed at very low levels (or not observed above detection limits) in groundwater. Most of the contamination likely occurred in the past.

12. **Comment:** (oral comment by Mr. Rich Yanss at the public meeting) *The groundwater monitoring [results] for the next five years will [be] compared to what?*

Response: The results will be compared to water quality standards for marine waters for protection of marine organisms, the National Toxics Rule for protection of human health, and so on. These are summarized in Section 8.0.

13. **Comment:** (oral comment by Mr. Rich Yanss at the public meeting) *Would we also compare it to samples that have already been accumulated?*

Response: We would also look at time trends (i.e., how the concentrations vary over long time periods).

14. **Comment:** (oral comment by Mr. Richard Brooks at the public meeting) *Based on your modeling of OU A, do you know what the contaminant load from the groundwater pathway is?*

Response: We made that estimate, which was part of the final feasibility study. We are now in the process of confirming some estimates, specifically for arsenic because it shows up in the soils, groundwater, and marine sediments and tissue. Our initial estimate in the final FS was between 13 and 14 kilograms per year for the following dissolved metals: arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc. Our recent estimate for arsenic alone, as presented in the final groundwater modeling report (August 1996), is 7.5 percent higher than the previous estimate for arsenic, or approximately 16 kg/yr.

15. **Comment:** (oral comment by Mr. Brooks at the public meeting) *Are you going to be looking at the other operable units, the groundwater pathway, to look at the total loading of contaminants across the entire facility to look at the total loading into Sinclair Inlet...?*

Response: Yes, the significance of the chemical flux from OU A groundwater on marine resources will be evaluated under OU B.

16. **Comment:** (oral comment by Mr. Richard Brooks at the public meeting) *Are you going to be looking at the effectiveness of the remedial actions at the site [in the context of the results] at OU B?*

Response: We are in the remedial investigation phase at OU B. When we get to the feasibility study phase, we will evaluate a variety of alternatives (including different alternatives than the ones that were presented to you tonight) over the entire site and their impact from all of the operable units.

17. **Comment:** (oral comment by Mr. Field Ryan at the public meeting) *If [Mr. Richard Brooks] wants more details, is that the set of books over there that gives the details and the broad plan on the rest of the operable units?*

Response: The available documents include the remedial investigation, feasibility study, extra copies of the proposed plan, and the preliminary groundwater report. We are also conducting some additional groundwater modeling runs, as part of the predesign phase for placement of the riprap. That work is not done yet, but the report will be available when it is completed.

The full set of documents is available in the county library now.

18. **Comment:** (oral comment by Mr. Kal Leichtman at the public meeting) *We've looked at what the Navy had done in the past to contribute to contamination. How about these other jurisdictions that border Sinclair Inlet? Have they been advised what's going on? Have they been told to "clean up your act?"*

Response: The Operable Unit B marine study will determine the mass of contaminants entering Sinclair Inlet from the shipyard groundwater, surface water, and storm drains. The study will also attempt to identify other (e.g., off-site) sources of sediment contaminants. The Navy needs to know this because if the sediments are cleaned up under OU B, then there should be assurance that there are no other sources within Sinclair Inlet that would recontaminate the sediments.

19. **Comment:** (oral comment by Mr. Kal Leichtman at the public meeting) *The only thing that I'm concerned with is the aspect of human health. And I don't believe, at least in my own mind, there are any boundaries within Sinclair Inlet that belong to the Navy or to Harrison Hospital or to the County or to the ferry system and so forth.*

Response: For OU B, the risk assessment is currently ongoing, as is the evaluation of the nature and extent of chemicals in terrestrial and marine sediments. This analysis may indicate that there are other non-Navy past or ongoing sources that have contributed to elevated chemical levels within sediments in Sinclair Inlet.

20. **Comment:** (oral comment by Mr. Richard Brooks at the public meeting and restated in a letter from the Suquamish Tribe to Mr. John Gordon, dated May 31, 1996) *We were pleased to see that habitat enhancement will be one of the components to the preferred alternative. The placement of additional riprap along the shoreline of Sinclair Inlet will result in a net loss of aquatic habitat in Sinclair Inlet, and habitat mitigation is a necessary component to compensate for the loss of this habitat area.*

Response: As discussed in a roundtable meeting in April 1996 with representatives from the Navy, Washington State Department of Ecology (Ecology), Washington State Fish and Wildlife, the Suquamish Tribe, and URS Consultants, any proposed habitat enhancements will be discussed with stakeholders and designed in consultation with Ecology, the Tribe, and Fish and Wildlife. Statements by Fish and Wildlife staff at the same meeting indicated that careful design and placement of the fresh riprap may not result in significant impacts to marine waters and may require only minor engineering controls to prevent possible impacts.

21. **Comment:** (written comment by Mr. Richard Brooks in a letter from the Suquamish Tribe to Mr. John Gordon, dated May 31, 1996) *The Suquamish Tribe appreciates the opportunity to provide comments on the proposed cleanup plan for Puget Sound Naval Shipyard (PSNS), Operable Unit (OU) A...Source control measures implemented at PSNS will be an important component for the reduction of chemicals of concern in marine biota*

and sediment to acceptable human health and ecological risk levels. Fishery resources within Sinclair Inlet are important to the health and welfare of the Suquamish Tribe and are reserved to the Tribe under the Point Elliott Treaty of 1855.

Response: The Navy appreciates the Tribe's comments.

Comment: *The Tribe is concerned with the effectiveness of source control measures being proposed under the OU A preferred alternative and the total amount of contaminants being released from PSNS into Sinclair Inlet. At the public meeting on May 28, 1996, it was understood that as part of the OU B remedial investigation an evaluation of groundwater and other wastestreams will be assessed over the entire facility to determine the total discharge of contaminants from PSNS into Sinclair Inlet. These data should provide initial information on the effectiveness of remedial measures being proposed at the operable units, and indicate if additional remedial measures may be needed to reduce the total amount of contaminants being released into Sinclair Inlet from PSNS.*

Response: The Navy appreciates the Tribe's comments and concurs with your understanding.

Comment: *The proposed plan also describes restrictions on fish and shellfish harvesting. The Tribe would like it specified that these restrictions are for resident fish species (i.e., bottom fish, rock fish) and not for highly migratory fish species such as salmon.*

Response: Such restrictions are under the control and purview of the Washington State and county Health Departments; however, the Navy can provide advisories to these agencies. The Navy will work with state and local agencies and the Tribe to finalize the details of the fish and shellfish harvesting restrictions.

Comment: *The Tribe will accept the preferred alternative for OU A if: (1) language is included in the Record of Decision to indicate that remedial measures proposed for the operable unit will be reevaluated and may be modified based on information evaluated under the OU B remedial investigation; and, (2) adequate habitut mitigation is included to compensate for the loss of aquatic habitat from the placement of additional rip rap along the shoreline.*

Response: The recommended language to address the Tribe's first concern has been included in the ROD. We disagree that placement of new riprap will necessarily significantly impact aquatic habitat. The basis for including provisions for habitat enhancements is to improve the existing marine and terrestrial habitat in its current state. Careful design, planning, and construction (with input and review from the agencies, the Tribe, and the public) can be implemented to avoid long-term impacts.

22. **Comment:** (written comment from Ms. Kathy Dickerson, Indianola, Washington, sent to John Gordon, PSNS) *I think Alternative 4: Removal of materials from disposal pits in Zones I and II should be chosen, as it is more inclusive than Alternative 2. It is most protective, meets state requirements, reduces toxicity, has short term and long term effectiveness, [and the] removal technology is easily available. Particular concern for me is groundwater contamination and need to remove source of contaminants and to monitor groundwater carefully and for a long time.*

Response: The most recent groundwater sampling results, statistical analysis, and groundwater modeling studies suggest that, currently, contaminants are not being transported from the fill to Sinclair Inlet in significant quantities. Excavation of a portion of the site would: (1) move the contaminants to another (albeit more controlled) location, (2) may result in short-term mobilization of contaminants to Sinclair Inlet during the construction process, and (3) would result in much higher cleanup costs to reduce only slightly the existing risks associated with the groundwater pathway.

23. **Comment:** (written comment from Mr. John Moeller, Bremerton, Washington, sent to Mr. John Gordon, PSNS) *Build a handicap compatible pedestrian overpass at the Missouri Gate. This is a must!*

Response: The Navy appreciates your interest in the work at Operable Unit A and your comments about traffic circulation patterns in the greater Bremerton area. However, they do not pertain to the proposed plan and it is recommended that you contact the City of Bremerton and State Department of Transportation with your comments.

24. **Comment:** (written comment from Ms. Mindy Fohn, Poulsbo, Washington, sent to Mr. John Gordon, PSNS). *I have several concerns regarding OU A.*

a. *I don't see how <u>clean</u> riprap will reduce erosion.*

Response: Fresh riprap will be placed on the existing riprap, portions of which show exposed fill materials. The fresh riprap will act as a protective cover and reduce the degree of turbulence and erosion associated with tidal fluctuations and storm waves.

b. *I would like to see more extensive habitat enhancement; or at least some specifics. How can habitat be enhanced in an area with contaminated sediments? I would think sediment cleanup and habitat enhancement should be linked. You may do enhancement but considering the sediment pollution, this (habitat) may be negated by the conditions of the sediment?*

Response: Even though contamination of sediments has been documented, a submarine survey of marine habitat adjacent to the site suggests a fairly diverse population of marine organisms exists. Habitat enhancement and cleanup actions for the sediments will be coordinated within the context of ROD for OU B.

c. *I was alarmed at the HQ for ecological risk. These levels seem high; how will this cleanup action mitigate the ecological risk? I don't see where this cleanup action will have any impact on ecological risk.*

Response: The proposed cleanup for OU A does not directly address marine sediments by developing cleanup actions for the sediments. These actions will be addressed under the ROD for OU B. If this work indicates a need for further actions at OU A to protect marine resources, those actions will be defined in the FS and ROD for OU B. The placement of fresh riprap will reduce direct erosion of fill materials from portions of the shoreline.

d. *I would like to see more specifics on the shellfish harvesting issue. Will shellfish harvesting be "prohibited" or only "discouraged"? Have you (Navy) coordinated with the Bremerton-Kitsap County Health District? Will monitoring of shellfish tissue continue in order to address this issue?*

Response: The Navy will coordinate with State and local programs regarding the posting of warning signs. Shellfish harvesting is already prohibited because of elevated fecal coliform levels. There is no provision for monitoring of shellfish tissue under OU A. Ongoing monitoring may be undertaken by the State Health Department or the County under other programs. The evaluation of monitoring of marine resources will be addressed in the FS for OU B.

e. *Will there be continued long-term monitoring of groundwater wells and seeps? I have not reviewed the GW or seep data; but I am reluctant to say that 3 years of monitoring can be justifiable to give the impression that the level of contaminants are not increasing. Continued monitoring must be a part of this plan.*

Response: Continued monitoring of groundwater is an important element of the proposed action. A review of the remedial measures will be undertaken at least every 5 years after initiation of the selected remedial action. The frequency and duration of groundwater monitoring will be determined by concurrence of the Navy and the Agencies.

f. *Public education should be a part of the plan. There are opportunities here to educate the public. Some ideas:*

1. *Interpretive signs*

2. *Linking with community groups; such as the Citizens Action Community for Sinclair Inlet*

3. *Emphasize habitat enhancement*

4. *Recovery of Sinclair Inlet*

Response: The Navy very much appreciates your comments about the opportunities for public education in this cleanup program. We anticipate that there will be an educational component of the proposed institutional controls to advise the community about potential risks associated with marine resources and lifestyle choices that would increase exposure. We welcome your input and ideas in designing and implementing the habitat enhancement portion of this proposed cleanup.

My #1 concern is the ecological risk to Sinclair Inlet. I feel that the cleanup alternative does <u>not</u> adequately address this concern. <u>How will ecological risk be affected?</u>

Response: See response to Comment 24c.

25. **Comment:** (written comment from the Bremerton-Kitsap County Health District to Mr. John Gordon, PSNS)

a. The Health District supports the preferred cleanup alternative discussed in the Final Feasibility Study. However, this cleanup alternative cannot be considered the final word on the remediation of OU-A. The following activities will contribute to the understanding of the effectiveness of the preferred cleanup actions:

1. The analysis of data collected from the ongoing monitoring of groundwater at OU-A; and

2. The results of the Remedial Investigation for Operable Unit B (OU-B).

The source controls recommended for OU-A may be the most cost-effective solution to minimizing environmental impacts to Sinclair Inlet. However, because it is difficult to assess the effectiveness of source controls in OU-A without considering the inputs of contaminants from other parts of PSNS—and without an analysis of ongoing monitoring data—additional or modified remedial measures may be needed at OU-A.

Response: Groundwater monitoring data for OU A are summarized in the Final RI Report. The RI for OU B is currently being prepared. The results of the statistical analysis conducted for OU A suggest that contaminant loads from groundwater to Sinclair Inlet are minor.

b. The Health District supports the preferred cleanup alternative with the understanding that the remediation of existing contamination in the marine sediments affected by OU-A will be addressed as part of the OU-B RI/FS process.

Response: The Navy appreciates your comment and agrees with the County's understanding that marine sediments will be addressed under OU B.

c. In support of the preferred alternative, the Health District recommends a short-term increase in the groundwater monitoring frequency for OU-A. Based on the limited amount of groundwater sampling events conducted to date, the seasonal variation in groundwater flow rates, direction, and quality have not been well defined, and the contaminant plume has not been delineated (mapped). The Health District recommends quarterly monitoring for a two year period to better describe this information. More limited monitoring of a subset of wells and parameters may be acceptable during the two-year study. Based on a review of this monitoring data, a reduction in the sampling frequency may be appropriate after that time. This additional data would also assist with refining the groundwater model used for OU-A.

Response: The details of the location, analytes, and frequency of groundwater monitoring will be described in the post-ROD RD/RA work plan and will be available for comment and review.